

A Guide to the Common Diatoms at Water Pollution Surveillance System Stations

June 1966

U.S. DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration

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UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration
Water Pollution Surveillance
1014 Broadway, Cincinnati, Ohio 45202

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Preface

Plankton studies were initiated in 1957 under the direction of Dr. Clarence M. Tarzwell and Dr. C. Mervin Palmer. The studies which they initiated were a part of the Public Health Service program to collect basic data on the quality of water in major waterways. In the beginning plankton studies were limited to Sedgwick-Rafter counts of phytoplankton and zooplankton. As the phytoplankton populations at the various stations were characterized, the dominant role of the diatoms became apparent, and preparations were begun for more intensive work with these forms. After the early species identifications were made through consultations or correspondence with Dr. Matthew Hohn, Dr. Charles Reimer, Dr. Friedrich Hustedt, and Dr. G. D. Hanna, routine diatom species identification and enumeration were inaugurated in 1959 by Dr. Louis G. Williams, who was in charge of plankton studies from September 1958 to December 1962. Dr. Cornelius I. Weber assumed responsibility for the plankton studies in September 1963.

Mr. Louis Grivetti who was on the staff of the plankton laboratory from 1962-1964 developed the first draft of this guide to consolidate information which would be helpful to beginners in diatom identification work. The present form of this guide is the result of extensive additions and revisions by Dr. Weber and his staff.

The diatom studies have become a vital part of the plankton program. The specificity of the diatom data has rendered it especially useful in characterizing water quality.

Joseph B. Anderson
In Charge, Aquatic Biology

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Introduction

A comprehensive treatise on the diatoms of the United States is yet to be published. Existing references dealing with the algae of this country are either very provincial or shallow in their coverage of the diatoms, therefore a large number of domestic and foreign publications must be consulted to find descriptions of all of our common species. This is a formidable task for the beginning diatom student. Descriptions of the diatom species which are most frequently encountered at WPSS stations have been assembled in this illustrated guide which was prepared to serve as a bench reference for biologists in our laboratory who are being trained in diatom identification. The guide also contains a glossary and generic key. The key was constructed with the beginner in mind, and is based entirely on the shape and markings of the diatom cell wall as observed in material mounted in hyrax. No attempt was made to place the taxa in their proper phylogenetic order. Laboratory personnel are encouraged to consult the taxonomic references for species identification.

We are indebted to Dr. Charles Reimer, Dr. Eugene Stoermer, and Dr. Matthew Hohn for carefully reviewing the manuscript and making many helpful suggestions. We are also grateful to the various authors and publishers who have granted permission to use selected figures from their publications.

Staff biologists who have been engaged in diatom work and have contributed to the preparation of this manual include, Carol Scott, Julia Maloney, Albert Katko, Mary Jo Sage, Louis Grivetti, Ronald Raschke, Mason Fenwick, Lydia Corrill, and Gretchen Oswald.

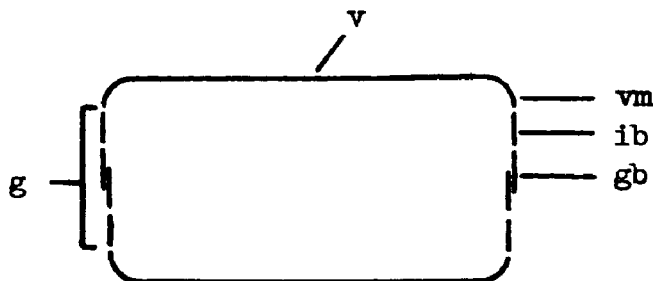
Cornelius I. Weber, Ph.D.
In Charge, Plankton Studies

Collection and Preparation of Diatom Material

The Water Pollution Surveillance System plankton samples used for diatom analyses are obtained from water plant intakes or directly from rivers or lakes at one hundred and thirty stations across the United States. The algae in the samples are concentrated by centrifuging twenty minutes at 1000 x G. Several drops of plankton concentrate are placed on a #1 coverglass, the coverglass is dried cautiously to avoid splattering, and incinerated thirty minutes on a hot plate at 1000°F. This treatment drives off most of the organic matter present, leaving only the siliceous diatom cell walls (thin-walled forms such as Rhizosolenia eriensis and Melosira crenulata may be difficult to observe). A drop of Hyrax mounting medium is placed in the center of a 75 mm x 25 mm glass slide heated to approximately 200°F. When the solvent has evaporated (the solvent-free Hyrax is hard and brittle at room temperature), the coverglass bearing the incinerated diatoms is inverted and placed on the drop of Hyrax, the slide is removed from the heat, and pressure is applied to the coverglass until the Hyrax cools and hardens (10 - 15 sec.). The finished slide is examined at 970X.

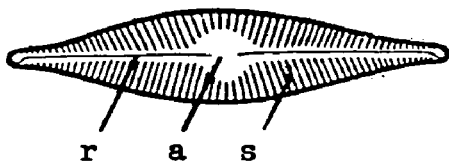
THE DIATOM CELL WALL

The diatom cell wall (frustule) is made of silica and consists of two overlapping halves, each composed of a more or less flat surface, the valve, to which are joined one or more hoop-like bands, the girdle and intercalary bands (see below).

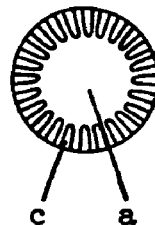


Girdle view of frustule showing valves, v; intercalary bands, ib; girdle band, gb; girdle, g; and valve mantle, vm.

The valves of the centric diatoms are generally circular in outline, with their markings arranged symmetrically about a central point; whereas, the valves of the pennate diatoms are generally elongate (linear) with their markings arranged in transverse rows along each margin.



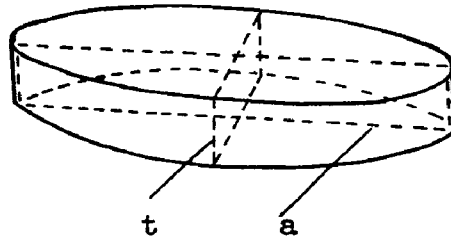
Pennate



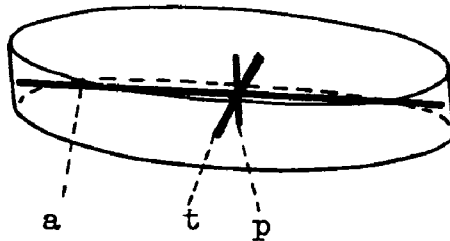
Centric

Valve views of pennate and centric diatoms showing the central area, a; raphe, r which usually occupies the medial axis of the valve; striae, s; and costae, c.

Planes and axes of symmetry are employed in keying out some of the pennate genera. They are shown in the figures below.



Oblique view of a pennate frustule showing planes; apical plane (along longitudinal or medial axis), a; transapical plane (along the transverse axis), t.



Oblique view of a pennate frustule showing axes: apical axis, a; transapical axis, t; and the perivalvar axis, p.

GLOSSARY

Arcuate - bent like a bow (see Fragilaria arcus, p. 38)

Brackish - having a dissolved salt content intermediate between fresh and salt water.

Capitate - swollen at one or both ends in valve view (see Caloneis amphisbaena, p. 63)

Carinal dots - circular or oval pores more or less evenly spaced along the keel, usually appearing as dots or lines (see Nitzschia, p. 90)

Costae - internal or external linear thickenings of the valve surface appearing as ribs; because of light diffraction, the tapered shoulders of the costae may appear as dark lines (see Cyclotella Meneghiniana, p. 26)

Facet - (alveola) a circular or hexagonal thin area in the valve surface, surrounded by a ridge which may extend internally or externally from the valve surface (see Coscinodiscus, p. 31)

Frustule - the siliceous diatom cell wall consisting of two separate halves.

Fusiform - broadest at the middle and tapering at each end, spindle-shaped (naviculoid).

Girdle - region of the frustule between the two valves.

Girdle-bands - the two overlapping hoop-like bands which join the two halves of the frustule. They may be connected directly to the valve margins or the intercalary bands.

Girdle view - side view of the frustule.

Intercalary bands - hoop-like bands located between the girdle-band and the valve (see Rhizosolenia, p. 22)

Keel - a ridge projecting from the valve-surface, enclosing the "canal" raphe, usually not medial on the valve (see Nitzschia, p. 89)

Linear - long and nearly uniform in width.

Micron - 0.001 millimeter.

Multiseriate - having more than one row of punctae (see Stephanodiscus astrea, p. 28)

Nodule - internal thickening of the cell wall in the central area or terminal portions (poles) of the valves of pennate diatoms.

Ocellus - a raised, rounded or ovate thickening of the valve surface having the appearance of a large pore (see Cyclotella ocellata, p. 27)

Poles - extreme ends of the valves of pennate diatoms.

Pseudoraphe - a smooth, linear space between the medial ends of the striae or costae on the valves of pennate diatoms. A term applied only to valves without a true raphe (see Synedra ulna, p. 45)

Punctae - small holes (pores) or thin, circular, sieve-like areas in the frustule.

Raphe - a fissure or slit in the valve face which may be along or eccentric to the medial axis of the valve; when located in a keel or wing it is referred to as a "canal" raphe.

Rhomboid - a parallelogram in which the angles are oblique and the adjacent sides are unequal (see Nitzschia, p. 89)

Septae - internal partitions or cross walls, usually appearing as dark lines (see Tabellaria fenestrata, p. 32)

Shadow-lines - dark "diffraction" lines which appear in the frustule wherever abrupt changes in thickness of the valve face occur (see Caloneis, p. 63)

Sigmoid - s-shaped (see Gyrosigma, p. 67)

Stellate - star-shaped, radiating from a point.

Striae - linear markings on the frustule which are due to closely placed punctae, or to hollow chambers in the cell wall (may sometimes appear as costae).

Sulcus - annular groove between the valve mantle and girdle (see Melosira ambigua, p. 19)

Uniseriate - having one row of punctae (see Coscinodiscus, p. 31)

Valve - the face of the diatom frustule.

Valve mantle - the part of the valve which extends below the shoulder.

In the Melosiras the valve mantle is a cylindrical surface that may be 30 μ long (see Melosira granulata, p. 20)

Wing - a thin projection of the valve surface, more highly developed than a keel; generally arising near the margin of the valve, but sometimes arising near the medial axis. May enclose the "canal" raphe (see Surirella, p. 87)

GENERIC KEY

- 1a Valves with true raphe or pseudoraphe; ornamentation
transverse and/or longitudinal..... 8
- 1b Valves without true raphe or pseudoraphe; ornamentation
radial about a central point..... 2
- 2a Frustules usually united into long filaments.....
Melosira (p. 19)
- 2b Frustules not usually united into long filaments; usually
solitary but may form short chains..... 3
- 3a Frustules with intercalary bands; usually seen in girdle
view; one or two long spines arising from each valve.... 4
- 3b Frustules without intercalary bands..... 5
- 4a One long spine arising from each valve.....
Rhizosolenia (p. 22)
- 4b Two long spines arising from each valve....Attheya (p. 23)
- 5a Valves with two marginal protuberances or horns on
opposite sides of the valve; usually seen in girdle view.
Biddulphia (p. 23)
- 5b Valves lacking protuberances..... 6
- 6a Valve margin with costae; ornamentation in central area
different from margin..... Cyclotella (p. 24)
- 6b Valve margin otherwise; central area not sharply distinct
from margin; valves with radial rows of punctae or with
geometric facets..... 7

- 7a Punctae in multiseriate rows near valve margin, each row gradually or abruptly becoming uniseriate toward the center; marginal spines always present.....
Stephanodiscus (p.28)
- 7b Punctae in uniseriate rows throughout, or with geometric facets..... Coscinodiscus (p. 31)
- 8a True raphe present on at least one valve; raphe may be very short or rudimentary, or may be concealed in a keel or wing..... 15
- 8b True raphe absent, pseudoraphe present on both valves... 9
- 9a Frustules with thick longitudinal septae running parallel to the valve faces..... Tabellaria (p.32)
- 9b Frustules without septae..... 10
- 10a Valves with thickened internal transverse ribs (costae), most of which extend completely across the valve face... 11
- 10b Valves without thickened internal transverse ribs..... 12
- 11a Valves symmetrical about the transapical plane.....
Diatoma (p. 33)
- 11b Valves asymmetrical about the transapical plane.....
Meridion (p. 36)
- 12a Frustules with bulbous ends, slightly concave in girdle view, typically forming stellate colonies.....
Asterionella (p. 37)
- 12b Frustules without bulbous ends, typically not forming stellate colonies..... 13

13a	Valves symmetrical about the transapical plane.....	14
13b	Valves asymmetrical about transapical plane..... <u>Opephora</u> (p. 38)	
14a	Frustules typically forming long ribbon-like chains, rarely solitary..... <u>Fragilaria</u> (p. 38)	
14b	Frustules typically solitary, sometimes forming stellate colonies; striae often appearing as costae..... <u>Synedra</u> (p. 42)	
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15b	Raphe not evident, concealed in a keel or wing.....	35
16a	Valves similarly ornamented, raphe on both valves.....	19
16b	Valves not similarly ornamented, raphe on one valve, opposing valve with pseudoraphe, or with rudimentary raphe near valve poles.....	17
17a	Valves elliptical, never linear, sometimes bent along the apical axis..... <u>Cocconeis</u> (p. 47)	
17b	Valves not elliptical, usually linear, and usually bent along the transapical axis.....	18
18a	Valves symmetrical about the transapical plane, one valve with completely developed raphe, opposing valve with pseudoraphe..... <u>Achnanthes</u> (p. 50)	
18b	Valves asymmetrical about the transapical plane, one valve with completely developed raphe, opposing valve with rudimentary raphe near valve poles..... <u>Rhoicosphenia</u> (p. 52)	

19a	Raphe rudimentary, short, near poles only.....	
	<u>Eunotia</u> (p. 53)	
19b	Raphe fully developed, extending the length of the valves.....	20
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	<u>Gomphoneis</u> (p. 54)	
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	<u>Gomphonema</u> (p. 54)	
23a	Valve faces parallel.....	<u>Cymbella</u> (p. 57)
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26a	Valves with longitudinal "shadow"-lines or blank spaces.....	27
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32a	Raphe enclosed in a siliceous rib..... <u>Diploneis</u> (p. 68)	
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33a	Valves with chambered striae appearing as heavy costae; valves usually with parallel sides and broadly rounded poles. <u>Pinnularia</u> (p. 70)	
33b	Valves with striae appearing otherwise.....	34

- 34a Central area extending laterally to the margins of the valve, striae absent along lateral margins of the central area..... Stauroneis (p. 70)
- 34b Central area not extending to the margins of the valve, striae present along lateral margins of the central area..... Navicula (p. 71)
- 35a Keel elevated into a lateral "wing" or flattened on the valve surface..... 37
- 35b Keel elevated into an axial "wing" extending along the central axis of the valve..... 36
- 36a Keel sigmoid, usually seen in girdle view (hour-glass-shaped), frustule twisted along the longitudinal axis; girdle broad with many longitudinal folds..... Amphiprora (p. 80)
- 36b Keel not sigmoid, girdle simple, not folded, keel eccentric..... Tropidoneis (p. 82)
- 37a Valves with numerous internal transverse ribs extending completely across the valve..... 38
- 37b Valves without internal transverse ribs..... 40
- 38a Raphe and axial area with "V"-shaped medial extension; with transverse septae appearing as costae and alternating with two or more rows of punctae..... Epithemia (p. 83)
- 38b Raphe and axial area without a "V"-shaped medial extension..... 39

- 39a Raphe canal with pores, valves symmetrical to longitudinal axis..... Denticula (p. 84)
- 39b Raphe canal without pores, valves asymmetrical to the longitudinal axis..... Rhopalodia (p. 84)
- 40a Valves with lateral keel extending along both margins of each valve..... 41
- 40b Valves with lateral keel extending along one margin of each valve..... 42
- 41a Valve face longitudinally undulate, undulations conspicuous in girdle view; with broad, short, peripheral costae; longitudinal pseudoraphe present.....
Cymatopleura (p. 86)
- 41b Valve face not longitudinally undulate; valve face with longitudinal folds which appear as heavy costae, folds not conspicuous in girdle view; girdle view rectangular, naviculoid, wedge shaped or sigmoid; valve view linear, elliptical, ovate or spirally twisted.....
Surirella (p. 87)
- 42a Keels eccentric to the median axis, diagonally opposite; frustules rhombic in cross section, transversely striate, punctate or lacking ornamentation; a row of circular pores ("carinal dots") developed within the keel; frustules usually solitary but occasionally forming irregular ribbon-like chains or stellate colonies.....Nitzschia (p. 89)
- 42b Keels eccentric to the median axis, directly opposite; frustules rectangular in cross section, transversely striate or punctate, capitate ends, medianly constructed...Hantzschia (p. 98)

Alphabetical list of Genera

<u>Genus</u>	<u>Page</u>	<u>Genus</u>	<u>Page</u>
Achnanthes	50	Gomphoneis	54
Amphipleura	62	Gomphonema	54
Amhiprora	80	Gyrosigma	67
Amphora	60	Hantzschia	98
Anomoeoneis	65	Mastogloia	68
Asterionella	37	Melosira	19
Attheya	23	Meridion	36
Biddulphia	23	Navicula	71
Caloneis	63	Neidium	64
Cocconeis	47	Nitzschia	89
Coscinodiscus	31	Opephora	38
Cyclotella	24	Pinnularia	70
Cymatopleura	86	Pleurosigma	67
Cymbella	57	Rhizosolenia	22
Denticula	84	Rhoicosphenia	52
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Eunotia	53	Surirella	87
Fragilaria	38	Synedra	42
Frustulia	62	Tabellaria	32
		Tropidoneis	82

Illustrated Species

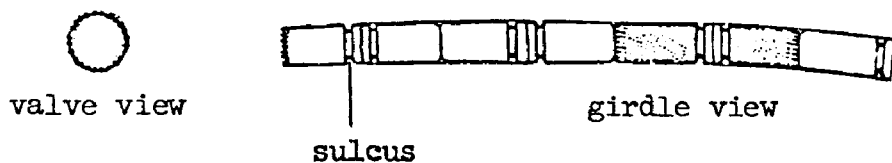
A total of 164 species are illustrated, representing 43 of the common genera found at the Water Pollution Surveillance System stations. Some of the species were selected primarily to demonstrate the morphological diversity within the genera. The figures have been selected from a number of publications (p. 18) and the figure credits are referred to by number immediately following the species names. The cell dimensions given are generally those from the figure source, but in some cases these have been supplemented with our own observations. The geographical distribution of 96 of the species is shown in the accompanying chart (p.100), taken from "Plankton Population Dynamics", by L. G. Williams, PHS Pub. No. 663, Suppl. 2, 1962. Additional information regarding diatom distribution can be found in the WPSS Annual Compilations of Data, 1960-61, 1961-62, and 1962-63, PHS Pub. No. 663.

FIGURE CREDITS

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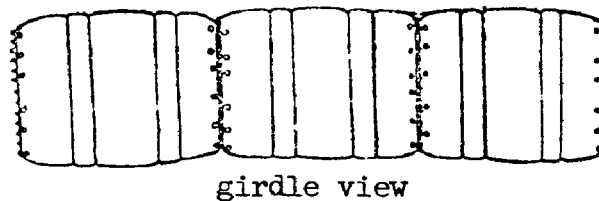
- 1a Valves with true raphe or pseudoraphe; ornamentation transverse and/or longitudinal 8
- 1b Valves without true raphe or pseudoraphe; ornamentation radial about a central point..... 2
- 2a Frustules usually united into long filaments - MELOSIRA¹

Fig. 1. Melosira ambigua, (3)², valves 4-15 μ in diameter, 3-13 μ long; wide, angular sulcus. X 1000. Abundant in the Ohio and Mississippi Rivers.



Notes:

Fig. 2. Melosira Binderana, (3), valves 4-25 μ in diameter, 3-7 μ long; in valve view may be confused with Stephanodiscus Hantzschii; has distinct pores on valve mantle (shoulder). X 1000. Common in the Great Lakes.



Notes:

-
1. Valve length in Melosira is measured from the valve face to the sulcus, along the perivalvar axis (half length).
 2. This number refers to the figure source.

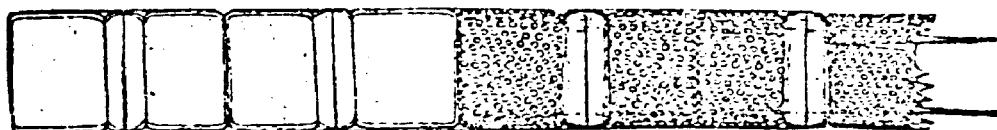
Fig. 3. Melosira distans, (3), valves $4-20\mu$ in diameter, $4-8\mu$ long. X 1000. Abundant in southeastern rivers.



girdle view
var. lirata,
form lacusris

Notes:

Fig. 4. Melosira granulata, (3), valves $5-21\mu$ in diameter, $5-18\mu$ long; terminal cells usually with robust spines. X 1000. Common in northern U. S.



girdle view
valve mantle

Notes:

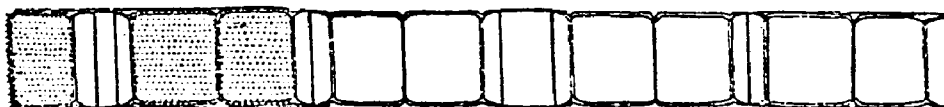
Fig. 5. Melosira herzogii, (7), valves 4μ in diameter, 7μ long. X 2000. Found most often in southeastern U.S.



girdle view

Notes:

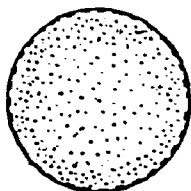
- Fig. 6. Melosira islandica, (3), valves 7-27 μ in diameter, 4-21 μ long; striae on valve mantle parallel to pervalvar axis. X 1000. Common in the Great Lakes and the Columbia River.



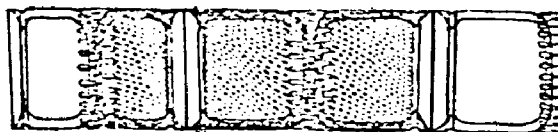
Notes:

girdle view,
subsp. helvetica

- Fig. 7. Melosira italica, (3), valves 5-28 μ in diameter, 8-21 μ long; differentiated from M. ambigua by more robust spines and narrow sulcus. X 1000. Common in the Columbia River.



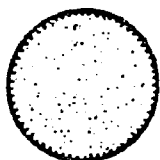
valve view



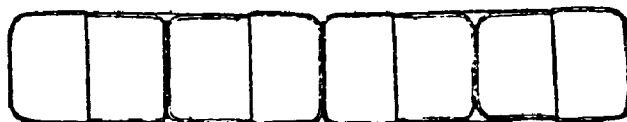
girdle view,
var. valida

Notes:

- Fig. 8. Melosira varians, (3), valves 8-35 μ in diameter, 9-13 μ long; no visible ornamentation. X 1000. Widely distributed.



valve view



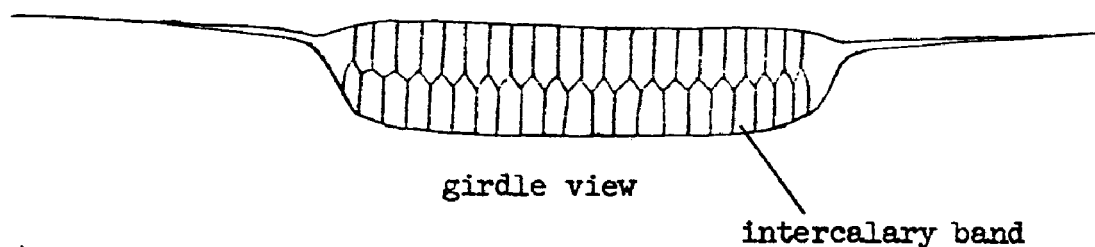
girdle view

Notes:

Notes on other species of MELOSIRA:

- 2b Frustules not usually united into long filaments;
usually solitary but may form short chains..... 3
- 3a Frustules with intercalary bands; usually seen in
girdle view; one or two long spines arising from each
valve..... 4
- 3b Frustules without intercalary bands..... 5
- 4a One long spine arising from each valve - RHIZOSOLENIA

Fig. 9. Rhizosolenia eriensis, (4), cells 5-15 μ in diameter,
40-150 μ long; note the many intercalary bands in the
girdle area. X 1000. Common in the Great Lakes.



Notes:

Fig. 10. Rhizosolenia minima, (4), cells $4-7\mu$ in diameter, $15-40\mu$ long (excluding spines). X 350. Southwestern U. S. (Red River).

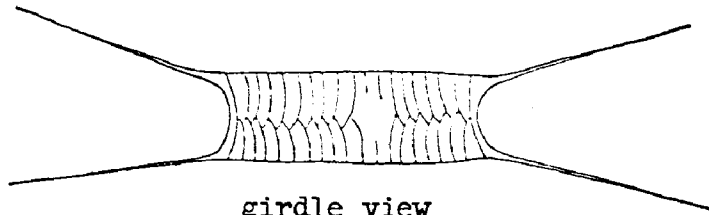


girdle view

Notes:

4b Two long spines arising from each valve - ATTHEYA

Fig. 11. Attheya Zachariasii, (10), cells $12-40\mu$ in diameter; spines $40-60\mu$ long. X 500. In Ohio and Tennessee Rivers.

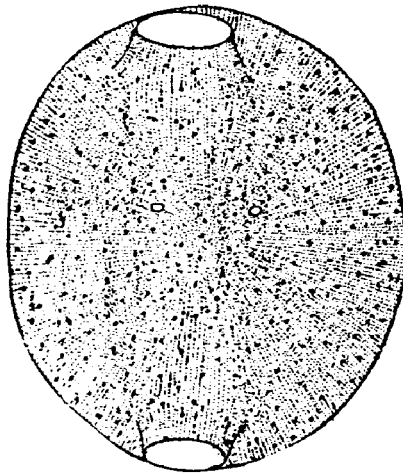


girdle view

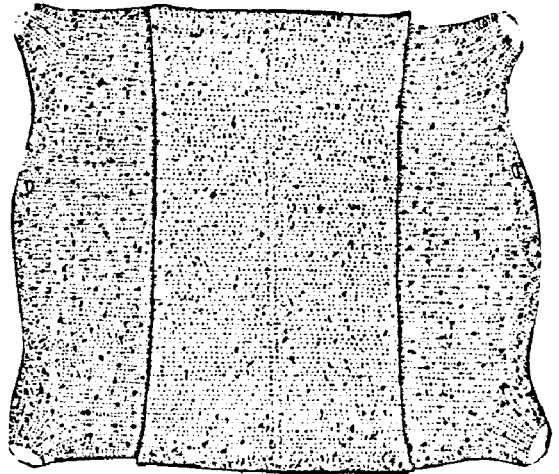
Notes:

5a Valves with two marginal protuberances or horns on opposite sides of the valve; usually seen in girdle view - BIDDULPHIA

Fig. 12. Biddulphia laevis, (10), cells 20-150 μ in diameter, 50-150 μ long; X 650. Southwestern U. S.



valve view



girdle view

Notes:

- 5b Valves lacking protuberances..... 6
- 6a Valve margin with costae; ornamentation in central area different from margin - CYCLOTELLA

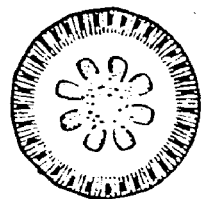
Fig. 13. Cyclotella atomus, (3), cells 4-5 μ in diameter; every 5th or 6th costae is thicker and darker than the others; single ocellus in central area. X 1500. Widely distributed.



valve view

Notes:

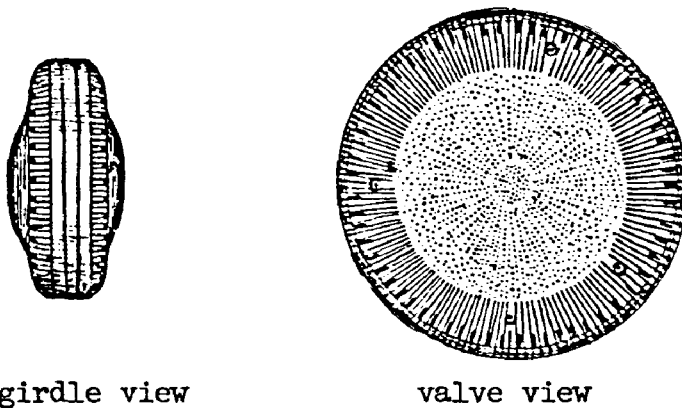
Fig. 14. Cyclotella antiqua, (4), cells 10-30 μ in diameter; wedge-shaped depressions in central area. X 1200. In Great Lakes.



valve view

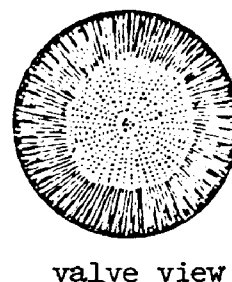
Notes:

Fig. 15. Cyclotella bodanica, (4), cells 20-80 μ in diameter; an isolated puncta occurs at the inner end of several shortened marginal costae. X 1000. In Great Lakes.



Notes:

Fig. 16. Cyclotella comta, (4), cells 15-20 μ in diameter; similar to C. bodanica but lacking punctae at the end of shortened costae. X 1000. In Great Lakes.



Notes:

Fig. 17. Cyclotella glomerata, (3), cells 4-10 μ in diameter; forming chains; often seen in girdle view. X 1000. In Great Lakes.

Notes:

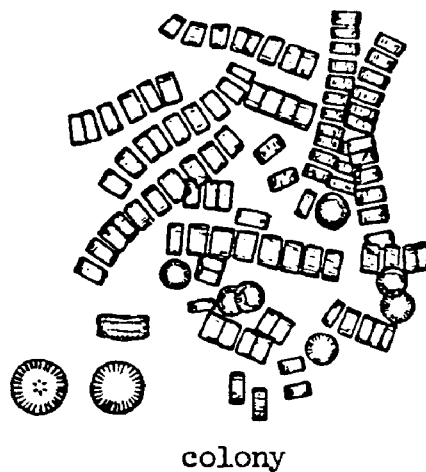
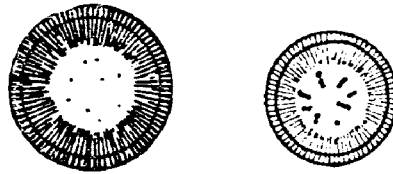


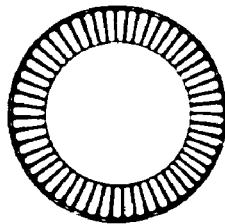
Fig. 18. Cyclotella Kutzingtoniana, (3), cells 10-20 μ in diameter; center ornamentation highly variable. X 1000. Common in Great Lakes.



valve views

Notes:

Fig. 19. Cyclotella Meneghiniana, (12), cells 10-30 μ in diameter; heavy marginal costae give impression of scalloped border. X 1000. Widely distributed.



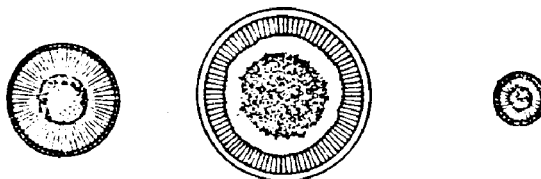
valve view



girdle view

Notes:

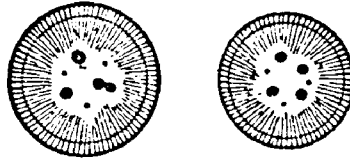
Fig. 20. Cyclotella michiganiana, (11), cells 5-20 μ in diameter; valve margin with pronounced rim. X 1000.



valve views

Notes:

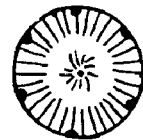
Fig. 21. Cyclotella ocellata, (3), cells 6-20 μ in diameter; central area with 3-4 ocelli. X 1000. In Great Lakes.



valve views

Notes:

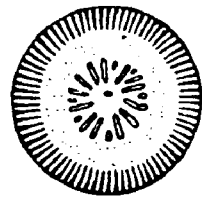
Fig. 22. Cyclotella pseudostelligera, (7), cells 7-8 μ in diameter; has marginal spines. X 3000. Widely distributed.



valve view

Notes:

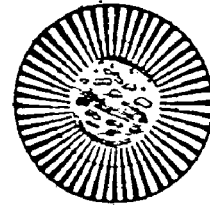
Fig. 23. Cyclotella stelligera, (3), cells 5-25 μ in diameter. X 1000. Abundant in the southeast.



valve view

Notes:

Fig. 24. Cyclotella striata, (4), cells 10-50 μ in diameter. Has a circular shadow line passing through the costae. X 1000. In Delaware and Hudson Rivers.



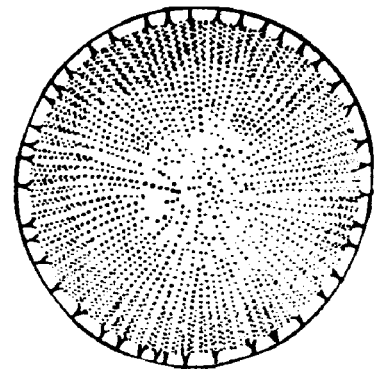
valve view

Notes:

Notes on other species of CYCLOTELLA

- 6b Valve margin otherwise; central area not sharply distinct from margin; valves with radial rows of punctae or with geometric facets..... 7
- 7a Punctae in multiseriate rows near valve margin, each row gradually or abruptly becoming uniseriate toward the center; marginal spines always present.- STEPHANODISCUS

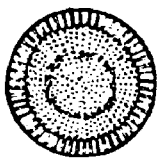
Fig. 25. Stephanodiscus astrea (3), cells 10-30 μ in diameter; spines not at end of each row of punctae. Outer punctae in double to quadruple rows, 12 punctae in 10 μ . X 1000. Widely distributed.



valve view

Notes:

Fig. 26. Stephanodiscus dubius, (3), cells 10-25 μ in diameter.
X 1000. In Great Lakes and Columbia River.



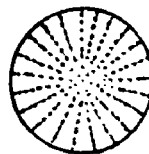
valve view



girdle view

Notes:

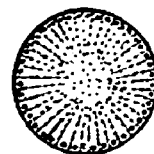
Fig. 27. Stephanodiscus Hantzschii, (7),
cells 8-20 μ in diameter; 8-10
striae in 10 μ ; striae very light;
frustule often collapses during
incineration; may be confused
with Melosira Binderana. X 2000.
Widely distributed.



valve view

Notes:

Fig. 28. Stephanodiscus invisitatus, (7),
cells 5-15 μ in diameter; 15-20
striae in 10 μ ; striae very light;
easily confused with S. Hantzschii.
X 2000. Ohio River Basin.

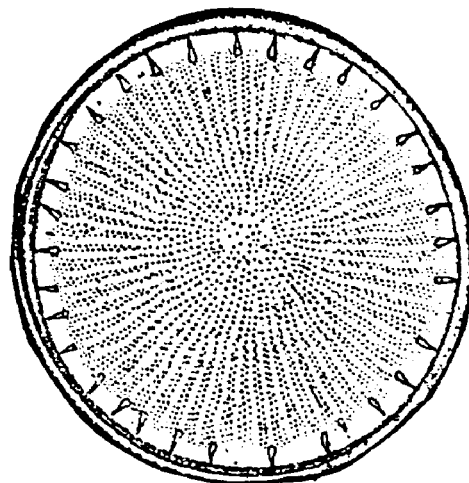


valve view

Notes:

Fig. 29. Stephanodiscus niagarae, (3),
cells 30-100 μ in diameter;
3-5 rows of punctae in marginal
region of striae, spines sub-
marginal and more robust than
in S. astrea. X 900. Upper
Mississippi and Missouri Rivers.

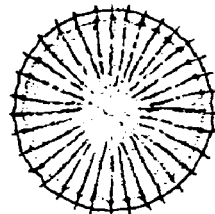
Notes:



valve view

Fig. 30. Stephanodiscus tenuis, (3),
cells 8-28 μ in diameter;
spines at end of each row
of striae. X 1000.

Notes:



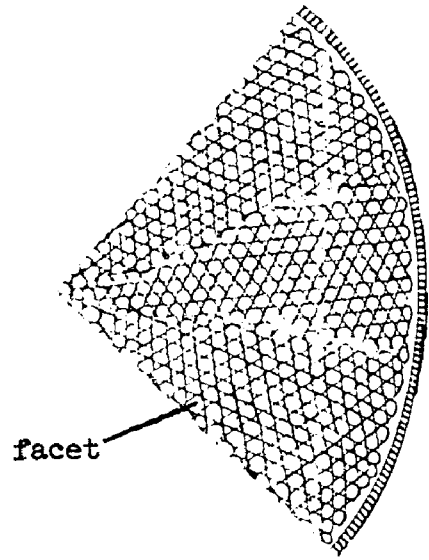
valve view

Notes on other species of STEPHANODISCUS.

- 7b Punctae in uniseriate rows throughout; or with geometric facets - COSCINODISCUS

Fig. 31. Coscinodiscus denarius, (4),
cells 40-90 μ in diameter.
X 1000.

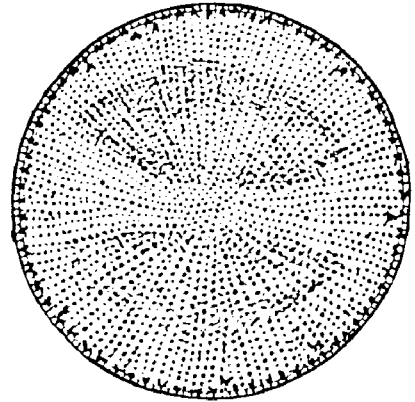
Notes:



valve view

Fig. 32. Coscinodiscus lacustris, (4),
cells 20-50 μ in diameter,
with marginal spines. X 1000.

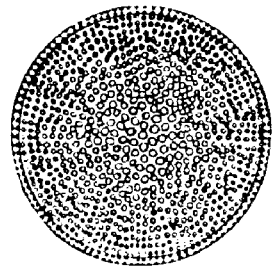
Notes:



valve view

Fig. 33. Coscinodiscus Rothii, (8),
cells 25-40 μ in diameter.
X 1000. In Red and Lower
Mississippi Rivers.

Notes:

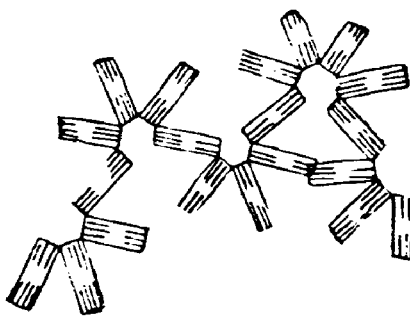


valve view

Other species of COSCINODISCUS.

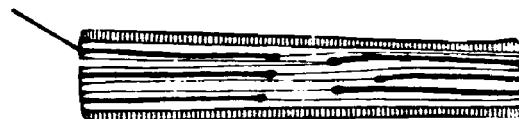
- 8a True raphe present on at least one valve; raphe may be very short or rudimentary, or may be concealed in a keel or wing..... 15
- 8b True raphe absent, pseudoraphe present on both valves..... 9
- 9a Frustules with thick longitudinal septae running parallel to the valve face - TABELLARIA.

Fig. 34. Tabellaria fenestrata, (3), cells 30-140 μ long, 3-9 μ wide; 18-20 striae in 10 μ ; 4-8 intercalary bands per cell. In Great Lakes and Columbia River.



Colony
X 250

septum



girdle view. X 1000



valve view. X 1000

Notes:

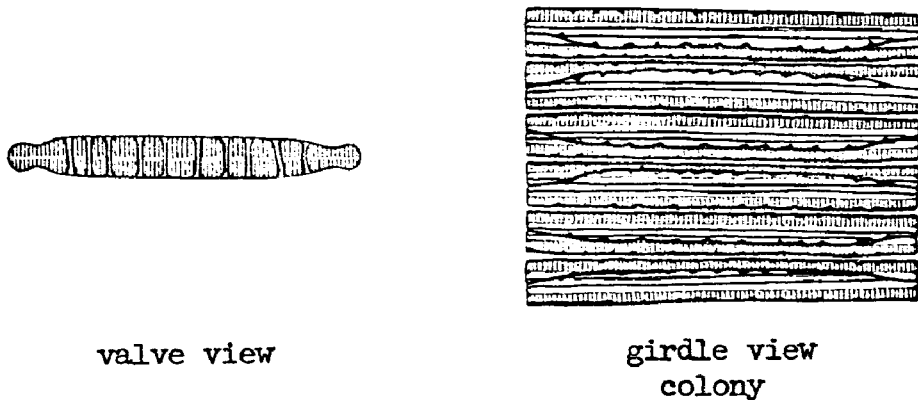
Fig. 35. Tabellaria flocculosa, (5), cells 12-50 μ long, 5-16 μ wide; about 18 striae in 10 μ ; many intercalary bands. X 1000. In Great Lakes and Columbia River.



Notes:

- 9b Frustules without septae..... 10
- 10a Valves with thickened internal transverse ribs (costae), most of which extend completely across the valve face..... 11
- 10b Valves without thickened internal transverse ribs..... 12
- 11a Valves symmetrical about the apical plane - DIATOMA

Fig. 36. Diatoma anceps, (5), cells 15-100 μ long, 4-8 μ wide; internal costae narrow, 3-6 in 10 μ ; striae delicate, 18-20 in 10 μ . X 1000. In Colorado River.

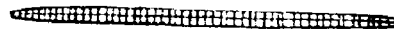


Notes:

Fig. 37. Diatoma elongatum, (5), cells 30-120 μ long, 2-4 μ wide; internal costae narrow, 6-10 in 10 μ ; striae delicate, about 16 in 10 μ . X 1000. In Great Lakes and Columbia River.



girdle view



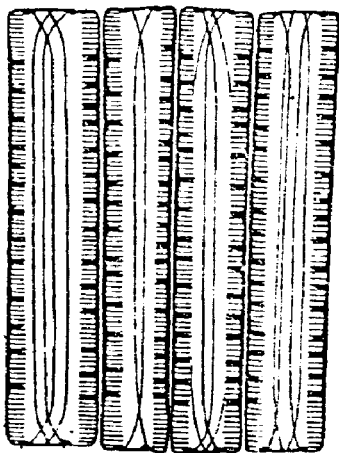
valve view of var.
tenuis



valve view

Notes:

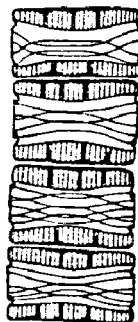
Fig. 38. Diatoma hiemale, (4), cells 15-100 μ long, 7-20 μ wide; internal costae robust, 2-4 in 10 μ ; striae prominent, 18-20 in 10 μ . X 1000.



girdle view of
part of colony



valve
view



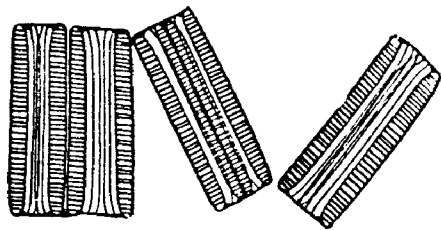
girdle view
of part of
colony of var.
mesodon



valve view
of var. mesodon

Notes:

Fig. 39. Diatoma vulgare, (5), cells 30-60 μ long, 10-13 μ wide; internal costae narrow, 6-8 in 10 μ ; striae very delicate, about 18 in 10 μ . Widely distributed.



Girdle view of
part of colony
X 500



valve view
X 1000



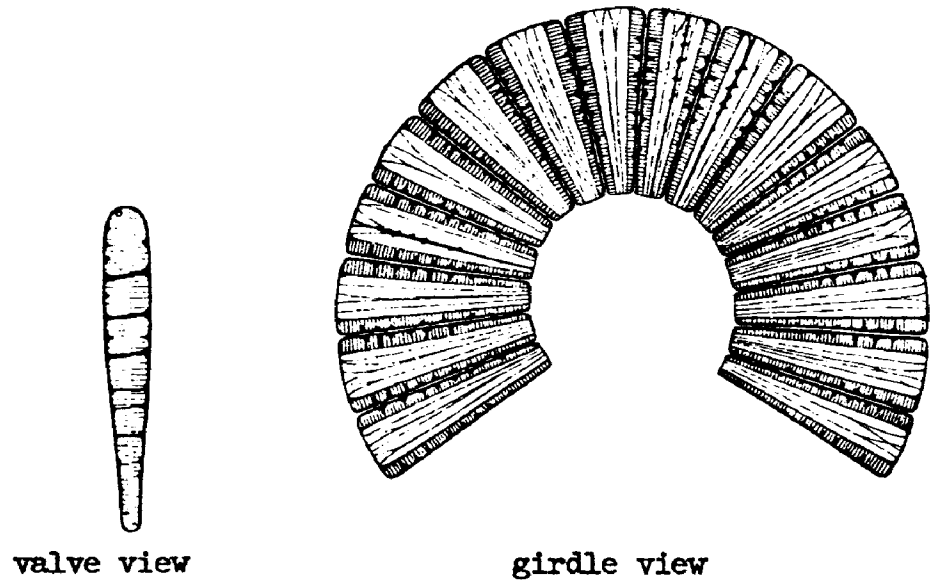
valve view,
var. brevis.
X 1000

Notes:

Notes on other species of DIATOMA.

11b Valves asymmetrical about the transapical plane - MERIDION

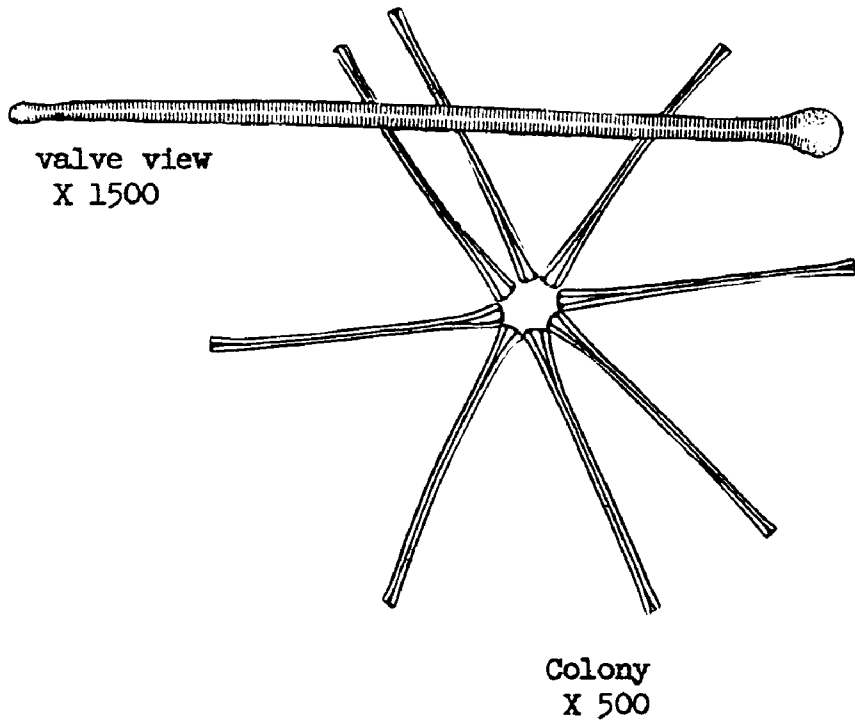
Fig. 40. Meridion circulare, (12), cells 12-80 μ long, 4-8 μ wide;
3-5 internal costae in 10 μ ; about 15 striae in 10 μ .
X 1000. Widely distributed.



Notes:

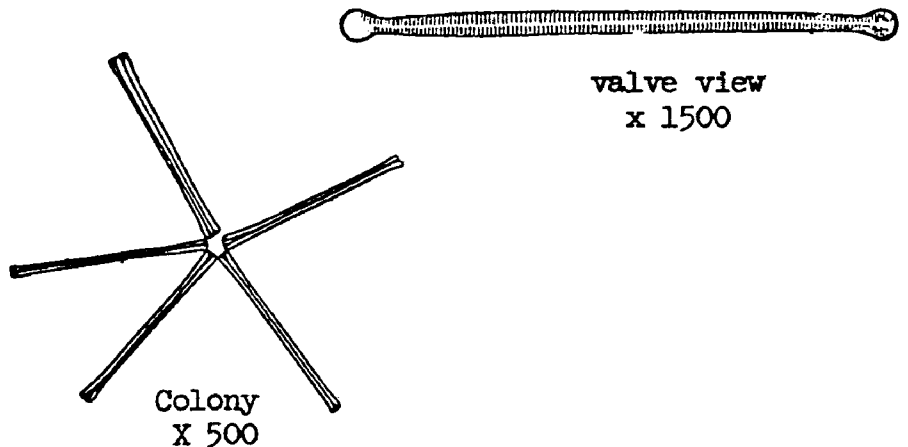
12a Frustules with bulbous ends, slightly concave in girdle view, typically forming stellate colonies - ASTERIONELLA

Fig. 41. Asterionella formosa, (3), cells 30-140 μ long, 1-2 μ wide; free ends inflated less than joined ends. Widely distributed.



Notes:

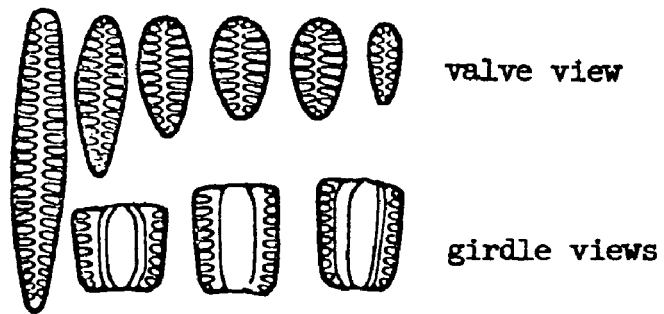
Fig. 42. Asterionella gracillima, (3), cells 40-130 μ long, 1-2 μ wide; similar to A. formosa except that the two poles of the cell are of equal size in both valve and girdle view.



Notes:

- 12b Frustules without bulbous ends, typically not forming stellate colonies..... 13
- 13a Valves symmetrical about the transapical plane..... 14
- 13b Valves asymmetrical about the transapical plane - OPEPHORA

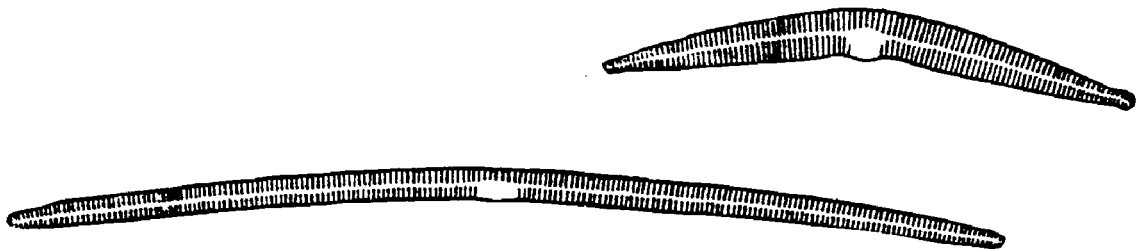
Fig. 43. Opephora Martyi, (4), cells 5-60 μ long, 4-8 μ wide; X 1000.



Notes:

- 14a Frustules typically forming ribbon-like chains, rarely solitary - FRAGILARIA

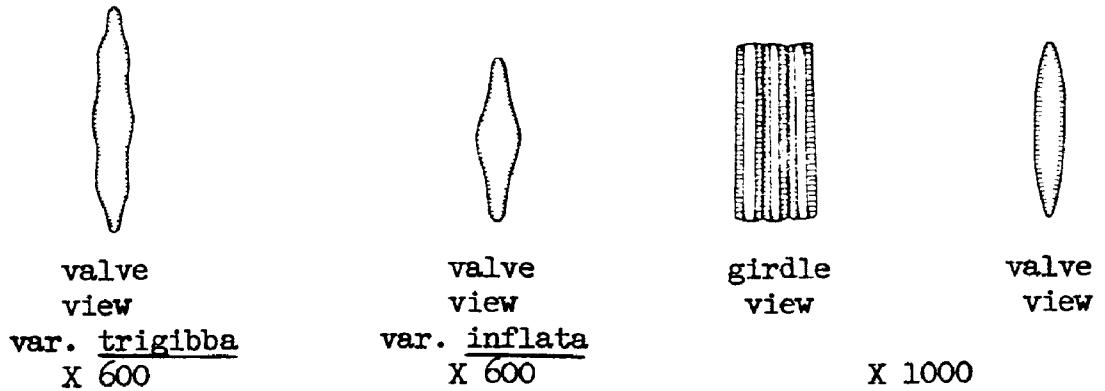
Fig. 44. Fragilaria arcus, (5), cells 15-150 μ long, 4-7 μ wide; 15-18 striae in 10 μ ; cells swollen on the concave side near the central area. X 1000. Abundant in the Delaware and Columbia Rivers.



valve views

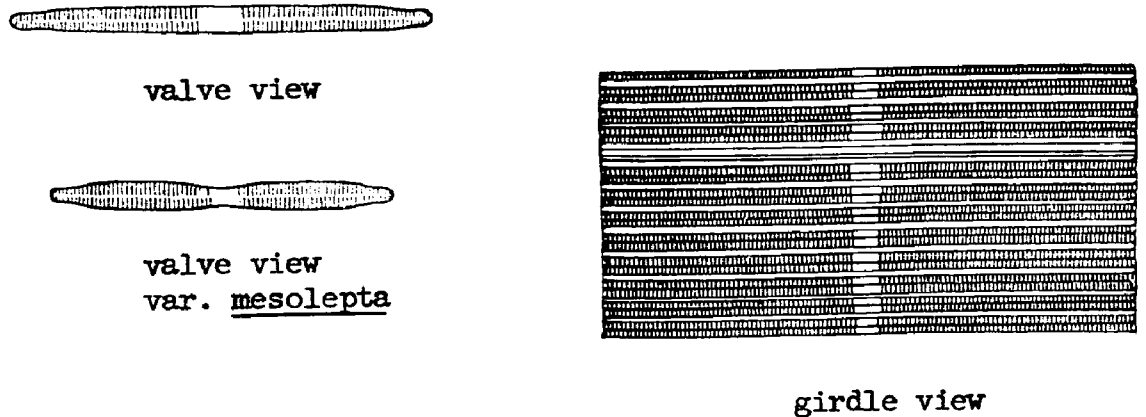
Notes:

Fig. 45. Fragilaria brevistriata, (5), cells 12-28 μ long, 3-5 μ wide; striae short, 13-17 in 10 μ .



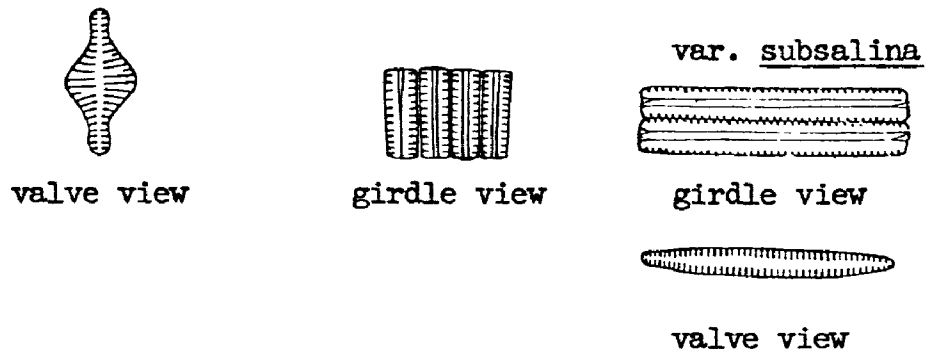
Notes:

Fig. 46. Fragilaria capucina, (3), cells 25-100 μ long, 2-5 μ wide; striae delicate, about 15 in 10 μ ; clear central area. X 1000. Abundant in northern waters.



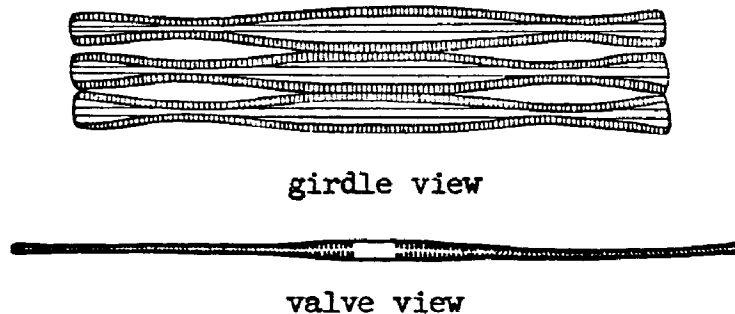
Notes:

Fig. 47. Fragilaria construens, (5), cells 7-25 μ long, 5-12 μ wide; striae delicate, 14-17 in 10 μ ; pseudoraphe broader in central region. X 1000. Abundant in northern waters.



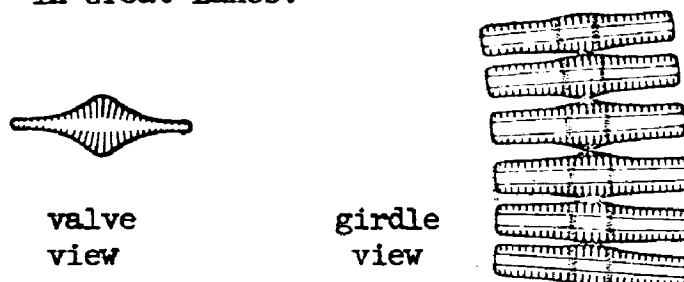
Notes:

Fig. 48. Fragilaria crotonensis, (3,5), cells 40-150 μ long, 2-3 μ wide; 15-18 striae in 10 μ . X 1000. Widely distributed.



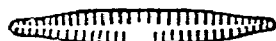
Notes:

Fig. 49. Fragilaria inflata, (12), cells 18-50 μ long, 6-10 μ wide. X 1200. In Great Lakes.

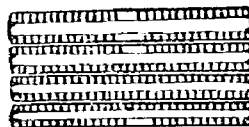


Notes:

Fig. 50. Fragilaria intermedia, (5), cells 15-60 μ long, 2-5 μ wide; 9-13 striae in 10 μ ; central area clear on one side only. X 1000.



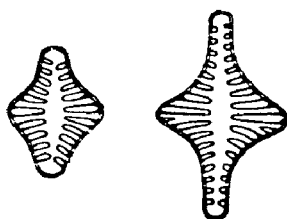
valve view



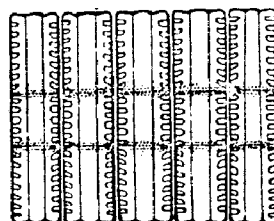
girdle view

Notes:

Fig. 51. Fragilaria leptostauron, (12), cells 13-30 μ long, 10-16 μ wide; striae coarse, 6-9 in 10 μ . X 1000.



valve views



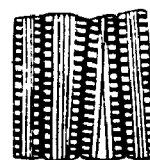
girdle view

Notes:

Fig. 52. Fragilaria pinnata, (5), cells 3-30 μ long, 2-6 μ wide; striae coarse 10-12 in 10 μ . X 1000. Widely distributed.



valve view

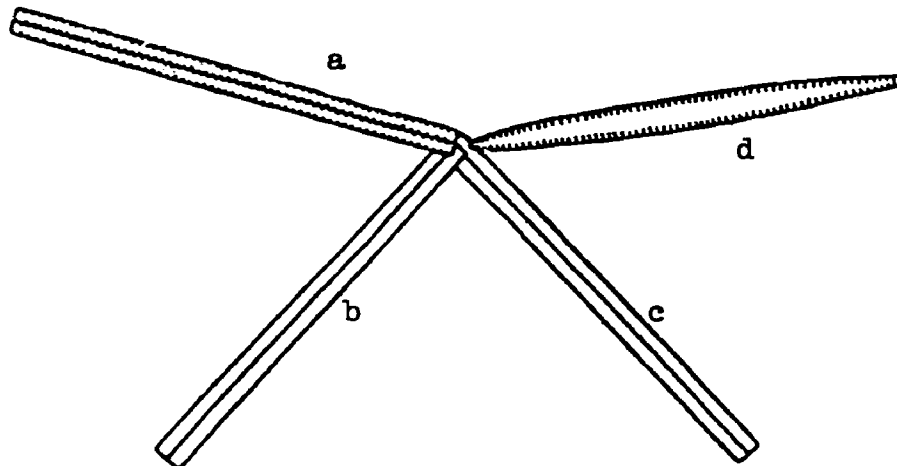


girdle view

Notes:

- 14b Frustules typically solitary, sometimes forming stellate colonies; striae often appearing as costae - SYNEDRA

Fig. 53. Synedra actinastroides, (5), cells 35-64 μ long, 2-4 μ wide; striae short, marginal, 14 in 10 μ . X 580.



a-c, girdle views
d, valve view

Notes:

Fig. 54. Synedra acus, (5), cells 100-300 μ long, 5-6 μ wide; striae 12-14 in 10 μ , finer than S. ulna. X 500. Widely distributed.

valve view, var. angustissima

valve view

valve view, var. radians

Notes:

- Fig. 55. Synedra nana, (5), cells 50-90 μ long, 1-2 μ wide; striae very light, 25-30 in 10 μ . X 1000. Widely distributed.



valve view

Notes:

- Fig. 56. Synedra parasitica, (5), cells 10-25 μ long, 3-5 μ wide; striae delicate, somewhat radial, 16-19 in 10 μ . X 1000. Sometimes parasitic on Nitzschia sigmoides.

Notes:

valve
views



S. parasitica

var.
subconstricta

- Fig. 57. Synedra pulchella, (5), cells 33-150 μ long, 5-8 μ wide; about 12-15 striae in 10 μ (sometimes as many as 20); large clear refractive central area. X 1000.

valve views



S. pulchella



var. lanceolata
form constricta



var.
minuta

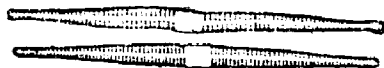


var. naviculacea

Notes:

Fig. 58. Synedra rumpens, (5), cells 15-70 μ long, 2-3 μ wide; 19-20 striae in 10 μ ; central area variable or completely absent. X 1000.

valve views



S. rumpens



var. familiaris



var. scotica

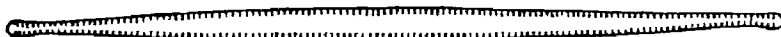


var. fragilarioides

Notes:

Fig. 59. Synedra tabulata, (5), cells 60-150 μ long, 2-5 μ wide; striae short, 10-14 in 10 μ . May form chains. X 1000.

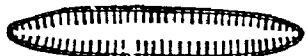
valve views



S. tabulata



var. fasciculata

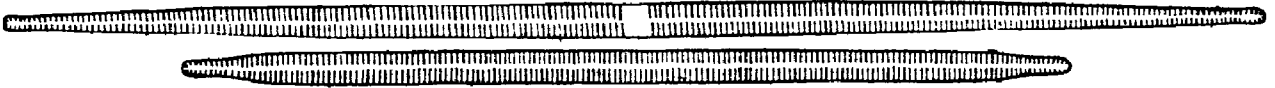


Notes:

Fig. 60. Synedra ulna, (5), cells 50-350 μ long, 5-9 μ wide; striae delicate, distinctly punctate, 8 - 12 (usually about 10) in 10 μ ; highly variable. X 600. Widely distributed.



girdle view, S. ulna



valve views, S. ulna

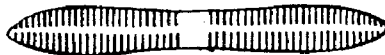
valve views



var. oxyrhynchus



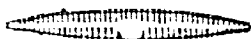
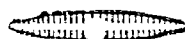
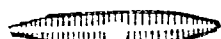
var. oxyrhynchus,
form contracta



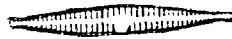
var. impressa

Notes:

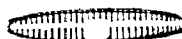
Fig. 61. Synedra Vaucheriae, (5), cells 10-40 μ long, 2-4 μ wide;
12-16 striae in 10 μ ; central area clear and thickened only
on one side. X 1000. Widely distributed.



valve views,
S. Vaucheriae



var. capitellata



var. truncata

valve views

Notes:

Notes on other species of SYNEDRA.

- 15a Raphe evident on at least one valve..... 16
- 15b Raphe not evident, concealed in a keel or wing..... 35
- 16a Valves similarly ornamented, raphe on both valves..... 19
- 16b Valves not similarly ornamented, raphe on one valve,
opposing valve with pseudoraphe, or with rudimentary
raphe near valve poles..... 17
- 17a Valves elliptical, never linear, sometimes bent along
the apical axis - COCONEIS

Fig. 62. Cocconeis diminuta, (5), cells 7-15 μ long, 5-9 μ wide, flat;
rapheless valve with 32 delicate striae in 10 μ ; raphe-
bearing valve with 13 coarsely punctate striae in 10 μ .
X 1000.



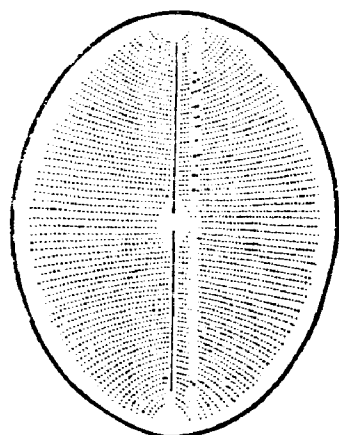
valve
with raphe



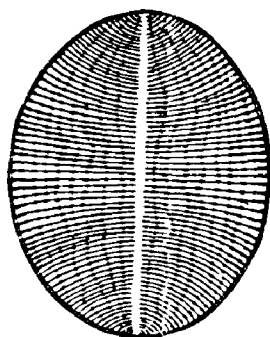
valve
without raphe

Notes:

Fig. 63. Cocconeis pediculus, (5), cells 15-56 μ long, 10-37 μ wide, strongly bent along the apical axis; valve with raphe has 16-18 distinctly punctate striae in 10 μ ; rapheless valve with 15-17 striae in 10 μ , which are crossed by several widely-spaced, undulating, longitudinal rows of coarse punctae. X 1000. Widely distributed.



raphe-bearing
valve



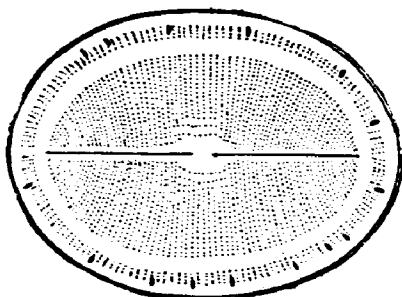
rapheless
valve



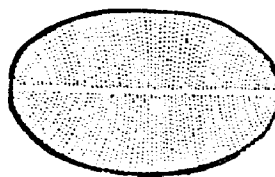
section through
transapical
plane; raphe-bearing
valve in ventral
position.

Notes:

Fig. 64. Cocconeis placentula, (5), cells 11-70 μ long, 8-40 μ wide, flat or only slightly curved; raphe-bearing valve with about 23 striae in 10 μ , rapheless valve with about 25 striae in 10 μ . X 1000. Widely distributed.



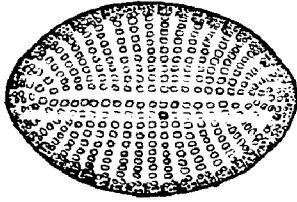
raphe-bearing
valve



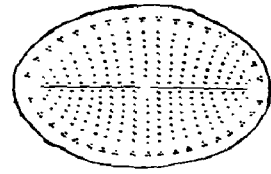
rapheless
valve

Notes:

Fig. 65. Cocconeis scutellum, (5), cells 20-60 μ long, 12-40 μ wide, flat. Rapheless valve with coarsely punctate striae. X 1000.



Rapheless valve



raphe-bearing valve

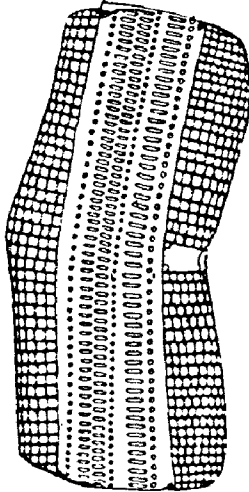
Notes:

Notes of other species of COCONEIS.

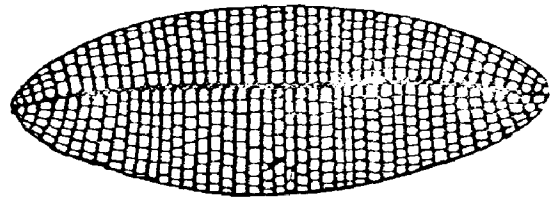
17b Valves not elliptical, usually linear, and usually bent along the transapical axis..... 18

18a Valves symmetrical about the transapical plane, one valve with completely developed raphe, opposing valve with pseudoraphe - ACHNANTHES

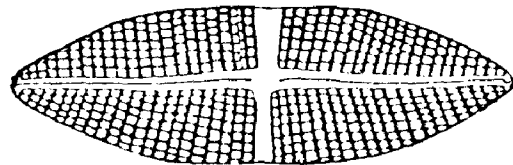
Fig. 66. Achnanthes brevipes, (5), cells 20-125 μ long, 12-30 μ wide; coarsely punctate. X 1000.



girdle view



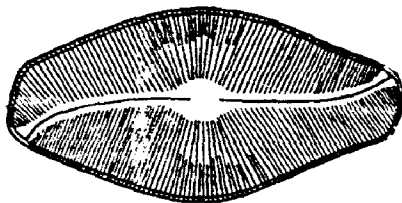
rapheless valve



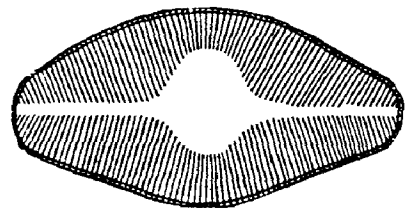
raphe-bearing valve

Notes:

Fig. 67. Achnanthes flexella, (11), cells 20-80 μ long, 10-26 μ wide; sigmoid raphe. X 1500.



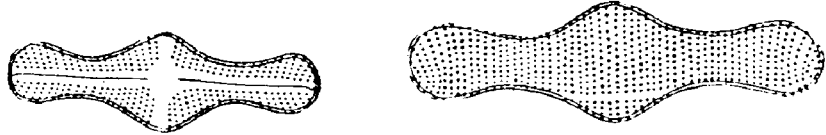
raphe-bearing valve



rapheless valve

Notes:

Fig. 68. Achnanthes inflata, (5), cells 30-65 μ long, 10-18 μ wide.
X 1000.



raphe-bearing valve

rapheless valve

Notes:

Fig. 69. Achnanthes lanceolata, (5), cells 5-40 μ long, 4-10 μ wide; striae prominent, 13-17 in 10 μ ; central area of rapheless valve with horseshoe-shaped spot. X 1500. Common in Great Lakes.



raphe-bearing
valve



rapheless
valve



rapheless valve of
var. rostrata

Notes:

Fig. 70. Achnanthes minutissima, (5), cells 5-40 μ long, 2-4 μ wide; striae delicate, about 35 in 10 μ . Curved girdle view very common. X 1500. Widely distributed.



raphe-bearing
valve



rapheless
valve



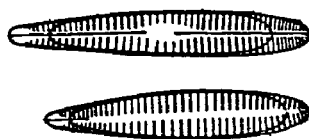
girdle view

Notes:

Notes on other species of ACHNANTHES.

- 18b Valves asymmetrical about the transapical plane, one valve with completely developed raphe, opposing valve with rudimentary raphe near valve poles - RHOICOSPHENIA

Fig. 71. Rhoicosphenia curvata, (5), cells 12-75 μ long, 4-8 μ wide; curved and wedge-shaped in girdle view; 12-15 striae in 10 μ . X 1000. Widely distributed.



valve views



girdle view

Notes:

19a Raphe rudimentary, short, near poles only - EUNOTIA.

Fig. 72. Eunotia pectinalis, (5), cells 40-140 μ long, 5-10 μ wide; arcuate in valve view, rectangular in girdle view; 7-12 striae in 10 μ . X 1000. Common in soft waters.

valve views



E. pectinalis



var. ventralis



var. undulata



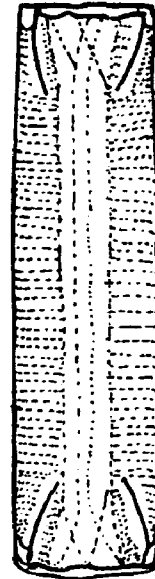
var. minor



var. minor
form impressa

girdle view

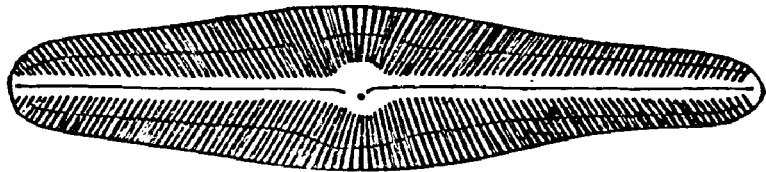
E. pectinalis



Notes:

- 19b Raphe fully developed, extending the length of the valves..... 20
- 20a Valves symmetrical about both the transapical and apical plane..... 24
- 20b Valves asymmetrical about either the apical or transapical plane..... 21
- 21a Valves symmetrical about the transapical plane, asymmetrical about the apical plane..... 23
- 21b Valves asymmetrical about the transapical plane, symmetrical about the apical plane..... 22
- 22a Valve margins with longitudinal "shadow"-lines - GOMPHONEIS

Fig. 73. Gomphoneis herculeana, (11), cells 30-136 μ long, 12-22 μ wide; 9-12 striae in 10 μ ; central area rounded with an isolated puncta. X 1000.

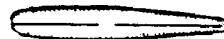


valve view

Notes:

- 22b Valve margins lacking longitudinal "shadow"-lines - GOMPHONEMA

Fig. 74. Gomphonema abbreviatum, (5), cells 7-34 μ long, 2-6 μ wide; 19-22 striae in 10 μ . X 1000.

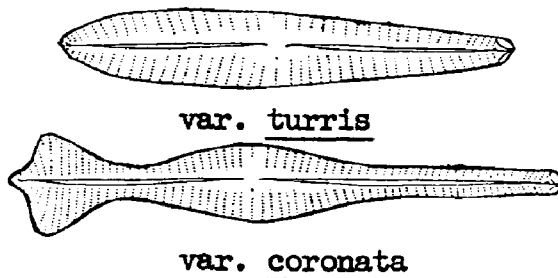


valve view

Notes:

Fig. 75. Gomphonema acuminatum, (5), cells 20-70 μ long, 5-11 μ wide; 10-13 striae in 10 μ ; one isolated puncta in the central area. X 1000.

valve views



Notes:

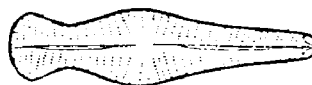
Fig. 76. Gomphonema angustatum, (5), cells 10-45 μ long, 5-9 μ wide; 9-14 striae in 10 μ ; one isolated puncta in the central area; easy to confuse with G. parvulum. X 1000.



valve views

Notes:

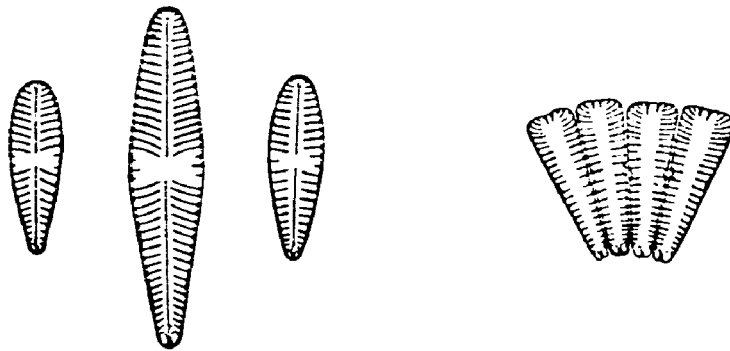
Fig. 77. Gomphonema constrictum, (5), cells 25-65 μ long, 8-14 μ wide; 10-12 striae in 10 μ ; one isolated puncta in the central area. X 1000.



valve view

Notes:

Fig. 78. Gomphonema olivaceum, (12), cells 10-40 μ long, 5-10 μ wide; 10-14 striae in 10 μ ; no isolated punctae in the central area. X 1000. Widely distributed.



valve views

girdle view

Notes:

Fig. 79. Gomphonema parvulum, (5), cells 8-30 μ long, 4-7 μ wide; 14-16 striae in 10 μ ; one isolated puncta in the central area. X 1000.

valve views



var.
subelliptica

var.
micropus

Notes:

Notes on other species of GOMPHONEMA.23a Valve faces parallel - CYMBELLA

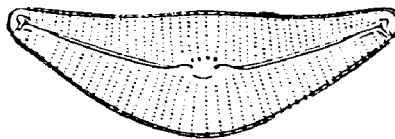
Fig. 80. Cymbella affinis, (5), cells 20-70 μ long, 7-16 μ wide; 9-12 striae in 10 μ ; ventral median striae ending in an isolated prominent puncta. X 1000.



valve views

Notes:

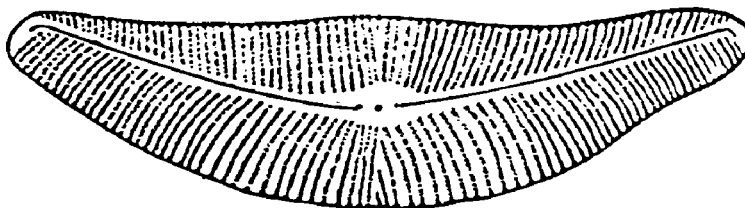
Fig. 81. Cymbella cistula, (5), cells 35-180 μ long, 15-36 μ wide; 6-9 striae in 10 μ ; two or more prominent punctae in the central area. X 1000.



valve view

Notes:

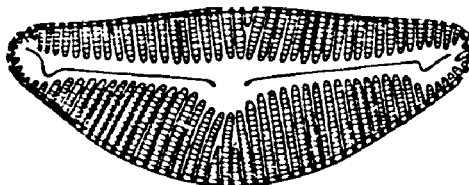
Fig. 82. Cymbella mexicanum, (1), cells 50-100 μ long, 20-40 μ wide; central area with a prominent puncta; similar to C. tumida, but striae have coarser punctae. X 800.



valve view

Notes:

Fig. 83. Cymbella prostrata, (5), cells 20-100 μ long, 10-30 μ wide; 7-10 striae in 10 μ . X 1000.



valve view

Notes:

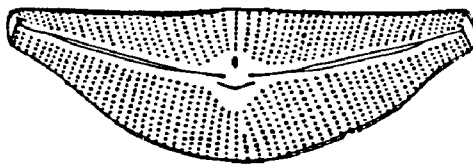
- Fig. 84. Cymbella sinuata, (5), cells 10-40 μ long, 4-9 μ wide; 9-11 striae in 10 μ ; do not confuse with Achnanthes sp. X 1000.



valve view

Notes:

- Fig. 85. Cymbella tumida, (5), cells 40-105 μ long, 15-23 μ wide; 8-10 striae in 10 μ ; central area with a ventrally placed isolated puncta. X 1000.



valve view

Notes:

- Fig. 86. Cymbella turgida, (5), cells 30-100 μ long, 9-25 μ wide; 7-9 striae in 10 μ ; similar to C. ventricosa, but larger and with more conspicuous punctae. X 1000.



valve view

Notes:

Fig. 87. Cymbella ventricosa, (5), cells 10-40 μ long, 5-12 μ wide; 12-18 striae in 10 μ ; raphe straight. X 1000.

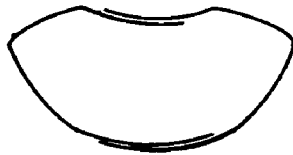


valve views

Notes:

Notes on other species of CYMBELLA.

23b Valve faces not parallel, both valve faces can be seen in girdle view - AMPHORA

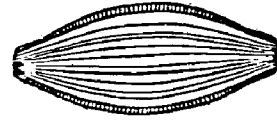


A diagrammatic polar view of Amphora, (7).

Fig. 88. Amphora coffeaeformis, (5), cells 20-50 μ long, 10-18 μ wide; 16-25 striae in 10 μ ; intercalary bands fine, about 21 in 10 μ . X 1000.



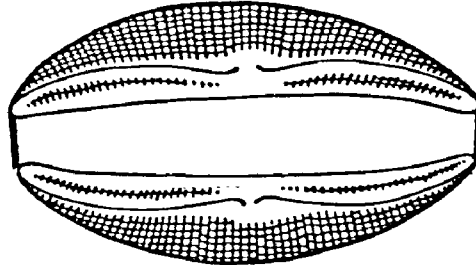
valve view



girdle view

Notes:

Fig. 89. Amphora ovalis, (5), cells 20-140 μ long, 17-63 μ wide; 10-13 striae in 10 μ . X 1000.



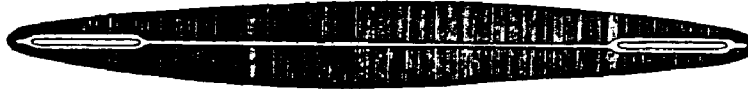
girdle view

Notes:

Notes on other species of AMPHORA.

- 24a Valves with elongate central or terminal nodules..... 25
- 24b Valves without elongate central or terminal nodules..... 26
- 25a Central nodule drawn out to at least half the length of the valve - AMPHIPLEURA

Fig. 90. Amphipleura pellucida, (8), cells 50-140 μ long, 7-9 μ wide; punctae delicate and difficult to see. X 1000.

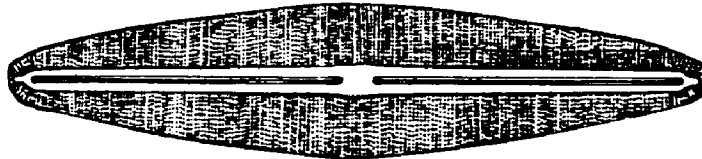


valve view

Notes:

- 25b Central nodule drawn out less than half the length of the valve - FRUSTULIA

Fig. 91. Frustulia rhomboides, (8), cells 50-160 μ long, 20-30 μ wide. X 1000.



valve view

Notes:

Fig. 92. Frustulia vulgaris, (5), cells 30-70 μ long, 10-13 μ wide.
X 1000.

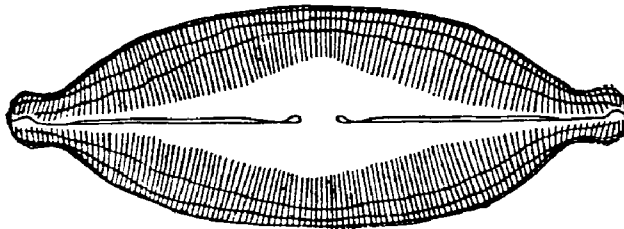


valve view
var. capitata

Notes:

- 26a Valves with longitudinal "shadow"-lines or blank spaces..... 27
- 26b Valves without longitudinal lines or blank spaces..... 29
- 27a Transverse striae continuous, crossed by one or two longitudinal "shadow"-lines paralleling valve margin - CALONEIS

Fig. 93. Caloneis amphisbaena, (5), cells 36-80 μ long, 20-30 μ wide.
X 1000. Common in the Rio Grande River.



valve view

Notes:

Fig. 94. Caloneis bacillum, (5), cells 15-45 μ long, 4-9 μ wide;
can be mistaken for Stauroneis sp. X 1000.



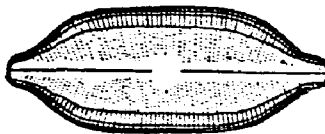
valve view

Notes:

Notes on other species of CALONEIS.

- 27b Transverse striae discontinuous, interrupted by blank spaces or "shadow"-lines..... 28
- 28a Longitudinal "shadow"-lines or blank spaces near valve margins; ends of raphe near central nodule usually turned in opposite directions - NEIDIUM

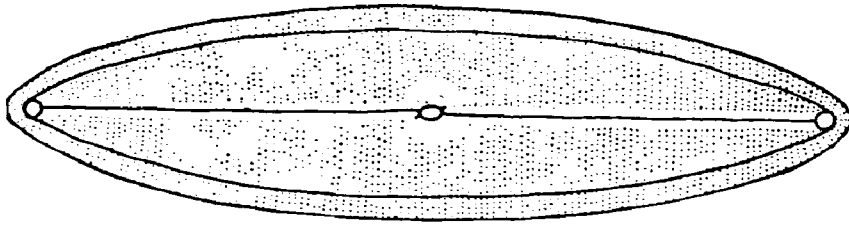
Fig. 95. Neidium dubium, (11), cells 30-46 μ long, 10-16 μ wide.
X 1000.



valve view

Notes:

Fig. 96. Neidium iridis, (11), cells 60-100 μ long, 23-24 μ wide.
X 1000.



valve view
var. firma

Notes:

Notes on other species of NEIDIUM .

- 28b Longitudinal "shadow"-lines or blank spaces scattered, central pores of raphe near central nodule turned if at all in the same direction - ANOMOEONEIS

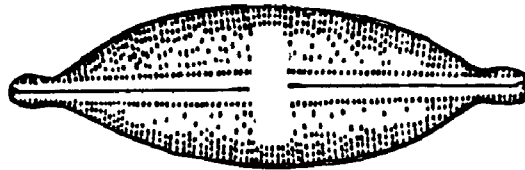
Fig. 97. Anomoeoneis exilis, (11), cells 10-35 μ long, 4-6 μ wide.
X 1000. Abundant in the southern Colorado River.



valve view

Notes:

Fig. 98. Anomoeoneis sphaerophora, (8), cells 40-80 μ long, 13-20 μ wide. X 1000.



valve view

Notes:

Notes on other species of ANOMOEONEIS

- 29a Valve and raphe sigmoid..... 30
- 29b Valves and raphe not sigmoid..... 31
- 30a Valves with transverse and longitudinal striae - GYROSIGMA

Fig. 99. Gyrosigma Kutzingii, (5), cells 60-120 μ long, 5-15 μ wide.
X 1000.



valve view

Notes:

Fig. 100. Gyrosigma scalproides, (5), cells 25-70 μ long, 5-10 μ wide. X 1000.

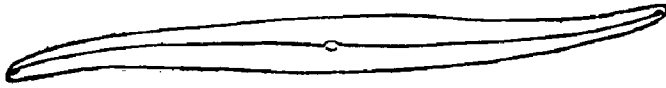


valve view

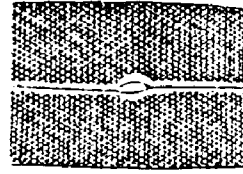
Notes:

- 30b Valves with transverse and oblique striae - PLEUROSIGMA

Fig. 101. Pleurosigma delicatulum, (10), cells 60-100 μ long, 10-15 μ wide.



valve view
X495

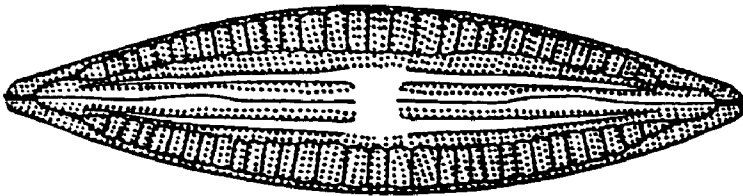


valve view
X1300

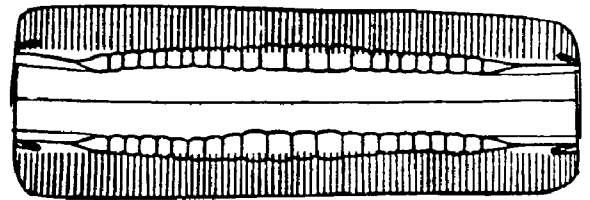
Notes:

31a Frustules with septae - MASTOGLIOIA

Fig. 102. Mastogloia Braunii, (5), cells 35-95 μ long, 14-27 μ wide.
X 1000.



valve view



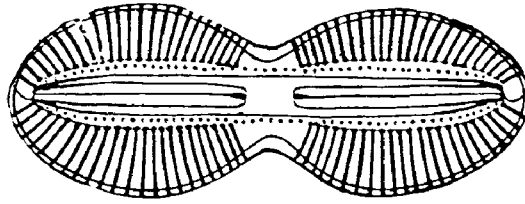
girdle view

Notes:

31b Frustules without septae..... 32

32a Raphe enclosed in a siliceous rib - DIPLONEIS

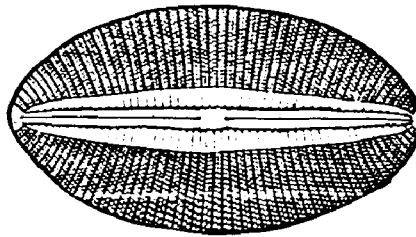
Fig. 103. Diploneis interrupta, (5), cells 30-80 μ long, 7-15 μ wide.
X 1000.



valve view

Notes:

Fig. 104. Diploneis Smithii, (5), cells 8-20 μ long, 5-10 μ wide.
X 1000. Abundant in the southwest.



valve view

Notes:

Notes on other species of DIPLONEIS.

32b Raphe not enclosed in a siliceous rib..... 33

33a Valves with chambered striae appearing as heavy costae; valves usually with parallel sides and broadly rounded poles - PINNULARIA

Fig. 105. Pinnularia borealis, (5), cells 20-110 μ long, 8-18 μ wide; 4-6 striae in 10 μ . X 1000.



valve view

Notes:

Fig. 106. Pinnularia gibba, (5), cells 50-140 μ long, 7-18 μ wide; wide axial area and broad capitate ends. X 1000.



valve view

Notes:

33b Valves with striae appearing otherwise..... 34

34a Central area extending laterally to the margins of the valve, striae absent along lateral margins of the central area - STAURONEIS

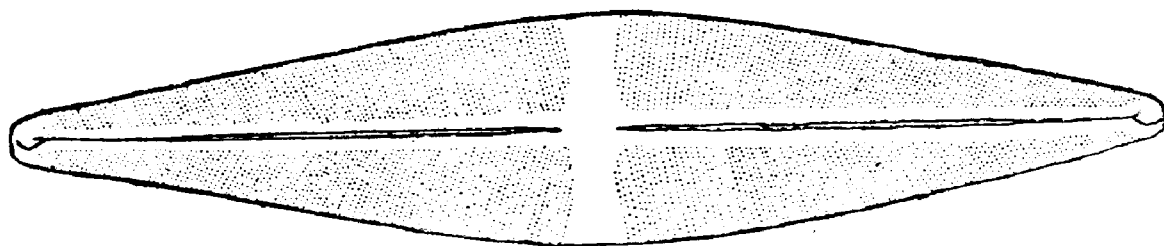
Fig. 107. Stauroneis crucicula, (1), cells $30-34\mu$ long, $8-12\mu$ wide; striae parallel to the branches of the stauros, 24 in 10μ . X 800.



valve view

Notes:

Fig. 108. Stauroneis phoenicentron, (11), cells $70-325\mu$ long, $16-53\mu$ wide; striae distinctly punctae, 12-20 in 10μ . X 1000.



valve view

Notes:

34b Central area not extending to the margins of the valve, striae present along lateral margins of the central area - NAVICULA

- Fig. 109. Navicula bacillum, (5), cells 20-80 μ long, 10-20 μ wide; central area rounded not quadrangular; middle striae, 12-14 in 10 μ , 18-20 striae in 10 μ near the poles; do not mistake for N. pupula. X 1000.



valve view

Notes:

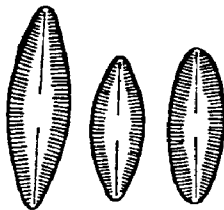
- Fig. 110. Navicula canalis, (2), cells 10-27 μ long, 3-5 μ wide; 16-18 striae in 10 μ . X 1000.



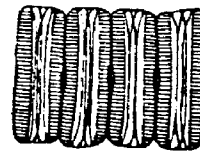
valve view

Notes:

- Fig. 111. Navicula confervacea, (4), cells 10-28 μ long, 5-8 μ wide; 18-22 striae in 10 μ ; may be found in chains like Fragilaria; raphe can be seen in girdle view. X 1000.



valve views



girdle view

Notes:

Fig. 112. Navicula contenta, (5), cells 5-15 μ long, 2-3 μ wide.
X 1500. May reach high numbers in southeastern brackish-
water stations.

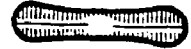
valve views



N. contenta



form parallela



form biceps

Notes:

Fig. 113. Navicula cryptocephala, (5), cells 20-40 μ long, 5-7 μ
wide; striae fine, 16-18 in 10 μ . X 1000.

valve views



N. cryptocephala



var. veneta

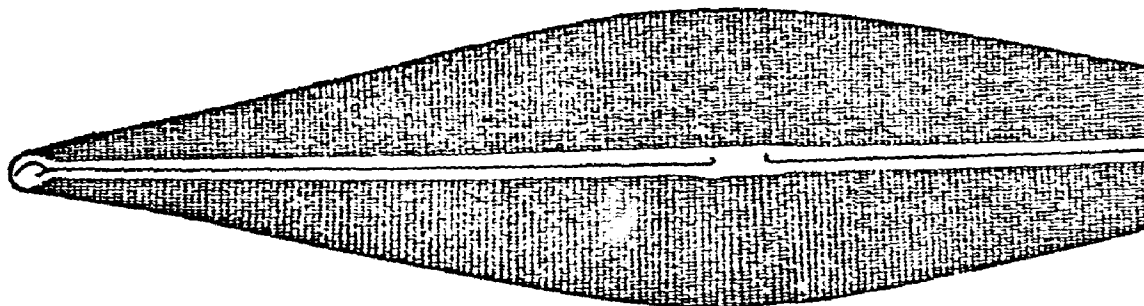


var. intermedia

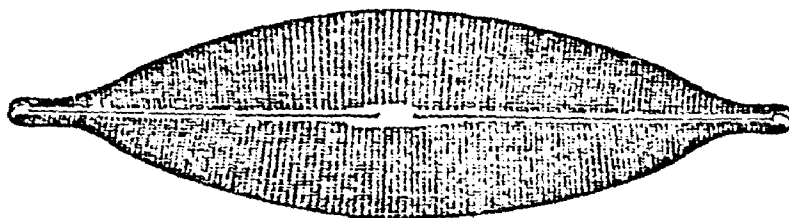
Notes:

Fig. 114. Navicula cuspidata, (5), cells 50-170 μ long, 17-37 μ wide; striae fine, 11-19 in 10 μ . X 1000.

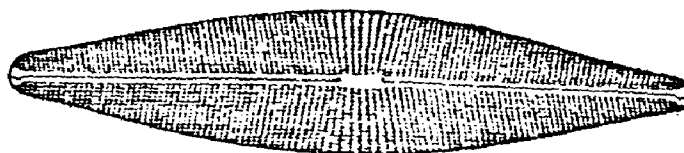
valve views



N. cuspidata



var. ambigua



Notes:

var. Heribaudi

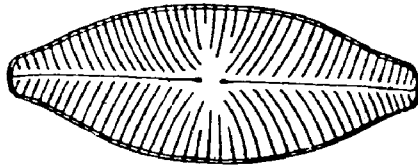
Fig. 115. Navicula exigua, (5), cells 10-35 μ long, 7-15 μ wide; 12-14 striae in 10 μ . X 1000.



valve view

Notes:

Fig. 116. Navicula gastrum, (5), 25-60 μ long, 12-20 μ wide; 8-10 striae in 10 μ . X 1000.



valve view

Notes:

Fig. 117. Navicula hungarica, (5), cells 10-30 μ long, 4-7 μ wide; 8-10 striae in 10 μ . X 1000. Abundant in the southwest.

valve views



N. hungarica



var. capitata

Notes:

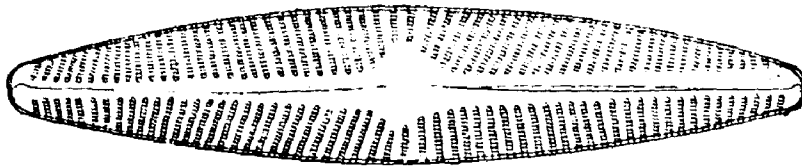
- Fig. 118. Navicula mutica, (5), cells 10-40 μ long, 7-12 μ wide; 15-20 striae in 10 μ ; single eccentric puncta in the central area. X 1500.



valve view

Notes:

- Fig. 119. Navicula peregrina, (5), cells 50-150 μ long, 10-30 μ wide; 5-6 striae in 10 μ . X 1000.



valve view

Notes:

- Fig. 120. Navicula pupula, (5), cells 20-40 μ long, 7-10 μ wide; 22-26 striae in 10 μ ; no striae at the poles; central area quadrangular; can mistake for N. bacillum. X 1000.



valve view
var. capitata

Notes:

Fig. 121. Navicula pygmaea, (5), cells 10-45 μ long, 8-24 μ wide; about 26 striae in 10 μ . X 1000.



valve view

Notes:

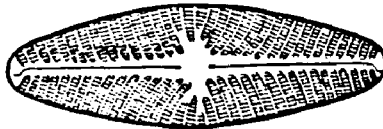
Fig. 122. Navicula radiosa, (5), cells 40-120 μ long, 8-20 μ wide; 10-12 striae in 10 μ . X 1000.



valve view

Notes:

Fig. 123. Navicula Reinhardtii, (5), cells 35-70 μ long, 14-20 μ wide; 7-9 striae in 10 μ . X 1000.



valve view

Notes:

Fig. 124. Navicula tripunctata, (5), cells 35-60 μ long, 6-10 μ wide; 11-12 striae in 10 μ ; central area quadrangular. X 1000.



valve view

Notes:

Fig. 125. Navicula viridula, (5), cells 36-80 μ long, 10-15 μ wide; 10 striae in 10 μ ; central area rounded. X 1000.



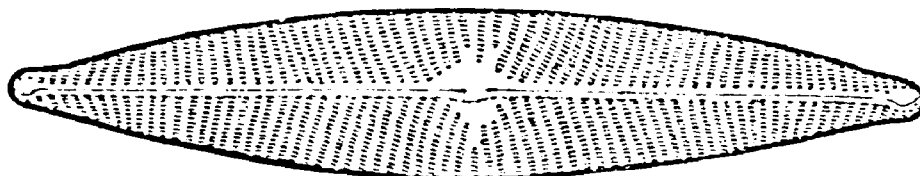
valve view

Notes:

Fig. 126. Navicula Zanoni, (6), cells 27-60 μ long, 7-11 μ wide; 13-14 striae in 10 μ ; can be confused with N. cryptocephala.



valve view
X 1000



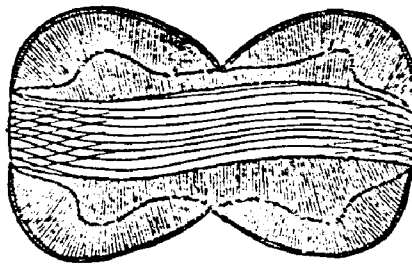
valve view
X 2000

Notes:

Notes on other species of NAVICULA.

- 35a Keel elevated into a lateral "wing" or flattened on the valve surface 37
- 35b Keel elevated into an axial "wing" extending along the central axis of the valve..... 36
- 36a Keel sigmoid, usually seen in girdle view (hour-glass-shaped), frustule twisted along the longitudinal axis; girdle broad with many longitudinal folds - AMPHIPRORA

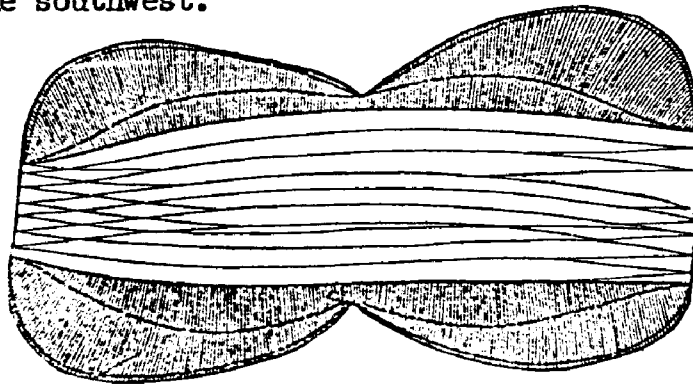
Fig. 127. Amphiprora alata, (5), cells 40-160 μ long, 20-60 μ wide; striae fine, punctae discernable. X 1000. Abundant in the southwest.



girdle view

Notes:

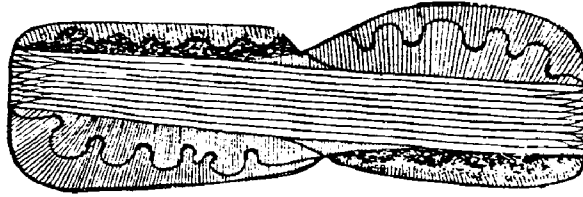
Fig. 128. Amphiprora paludosa, (5), cells 30-130 μ long, 15-50 μ wide; striae fine, punctae not discernable. X 1000. Abundant in the southwest.



girdle view

Notes:

Fig. 129. Amphiprora ornata, (5), cells 35-115 μ long, 15-40 μ wide; appears to be twisted in girdle view. X 1000.



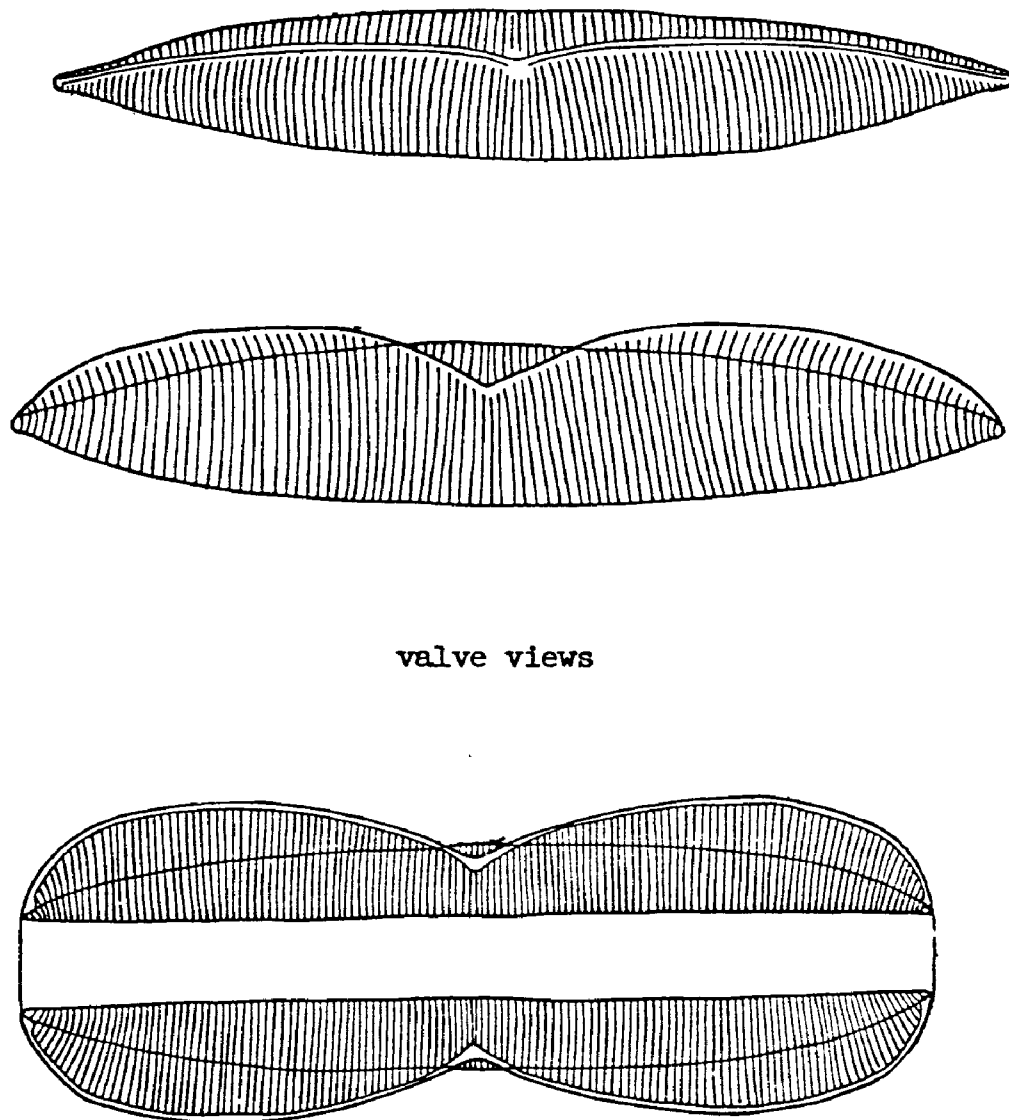
girdle view

Notes:

Notes on other species of AMPHIPRORA

- 36b Keel not sigmoid, girdle simple, not folded, keel eccentric -
TROPIDONEIS

Fig. 130. Tropidoneis lepidoptera, (9), cells 40-100 μ long, 10-15 μ wide; girdle view easily confused with Amphiprora sp.
 X 2000.



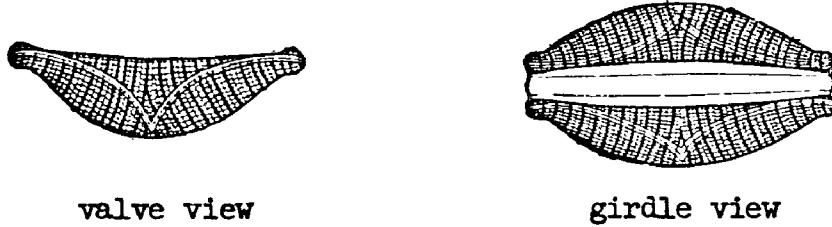
valve views

girdle view

Notes:

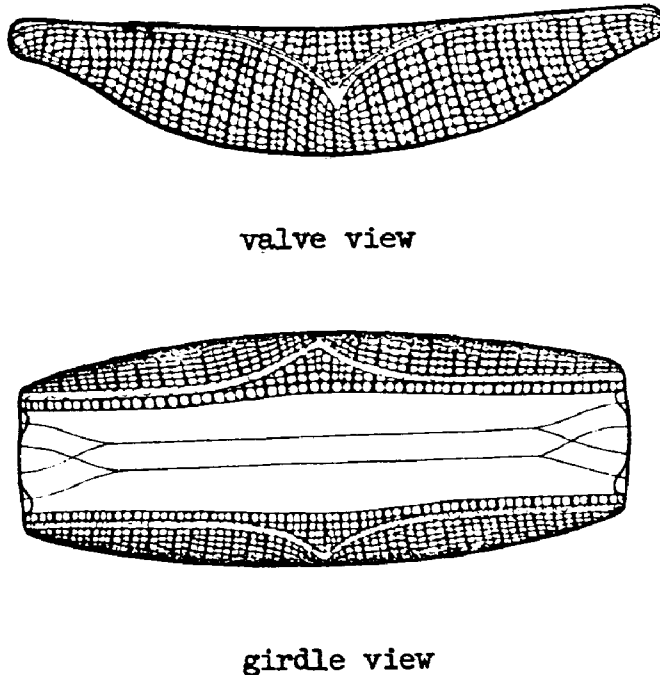
- 37a Valves with numerous internal transverse ribs extending completely across the valve..... 38
- 37b Valves without internal transverse ribs..... 40
- 38a Raphe and axial area with "V"-shaped medial extension; with transverse septae appearing as costae and alternating with two or more rows of punctae - EPITHEMIA

Fig. 131. Epithemia sorex, (12), cells 20-65 μ long, 8-15 μ wide; 5-7 septae in 10 μ ; 12-15 punctae rows in 10 μ . X 1000.



Notes:

Fig. 132. Epithemia turgida, (12), cells 60-220 μ long, 15-18 μ wide; 3-5 septae in 10 μ , 7-9 punctate rows in 10 μ . X 1000.



Notes:

Notes on other species of EPITHEMIA.

38b Raphe and axial area without a "V"-shaped medial extension..... 39

39a Raphe canal with pores, valves symmetrical to longitudinal axis - DENTICULA

Fig. 133. Denticula elegans, (5), cells 15-40 μ long, 5-7 μ wide; 3-5 transverse ribs in 10 μ ; 15-17 striae in 10 μ .



valve view

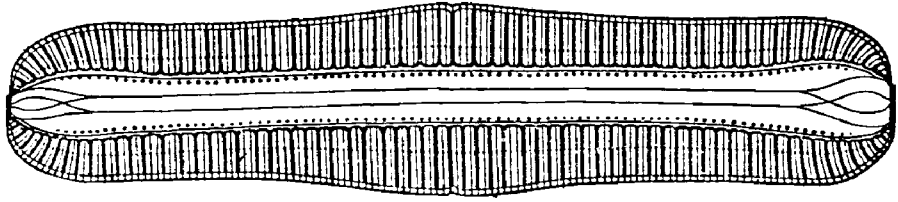


girdle view

Notes:

39b Raphe canal without pores, valves asymmetrical to the longitudinal axis - RHOPALODIA

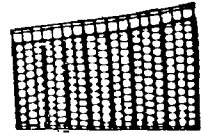
Fig. 134. Rhopalodia gibba, (12), cells 35-300 μ long, 6-30 μ wide; 6-8 costae in 10 μ ; 12-16 punctate rows in 10 μ .



girdle view
X 1200



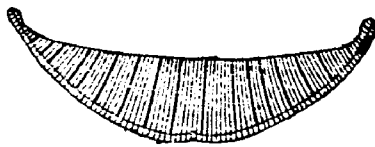
valve view
X 750



section of valve
X 2000

Notes:

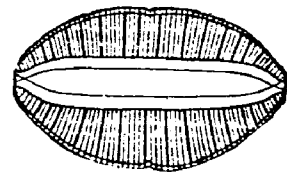
Fig. 135. Rhopalodia gibberula, (5), cells 25-80 μ long, 12-40 μ wide; 3-4 ventral costae in 10 μ , 14-17 punctate rows in 10 μ . X 1000.



valve view

var. van Heurckii

Notes:

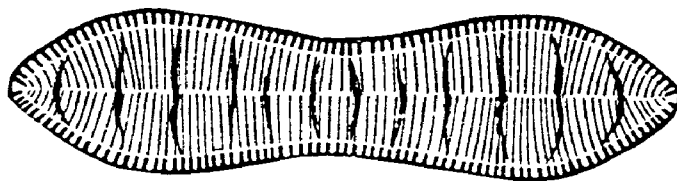


girdle view

Notes on other species of RHOPALODIA.

- 40a Valves with lateral keel extending along both margins of each valve..... 41
- 40b Valves with lateral keel extending along one margin of each valve..... 42
- 41a Valve face longitudinally undulate, undulations conspicuous in girdle view; with broad, short, peripheral costae; longitudinal pseudoraphe present - CYMATOPLEURA

Fig. 136. Cymatopleura solea, (5), cells 30-300 μ long, 12-40 μ wide. X 750.



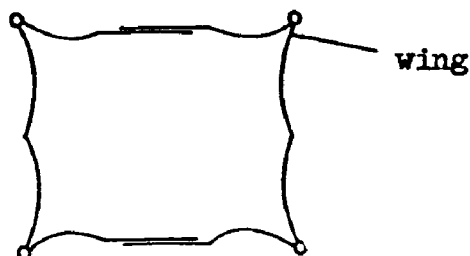
valve view



girdle view

Notes:

- 41b Valve face not longitudinally undulate; valve face with longitudinal folds which appear as heavy costae, folds not conspicuous in girdle view; girdle view rectangular, naviculoid, wedge-shaped, or sigmoid; valve view linear, elliptical, ovate, or spirally twisted - SURIRELLA

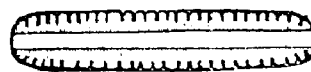


Diagrammatic cross-section
of Surirella, (7)

- Fig. 137. Surirella angustata, (5), cells 18-70 μ long, 6-20 μ wide; 6-9 longitudinal folds in 10 μ ; striae delicate, the only "common" Surirella that is transversely symmetrical. X 1000.



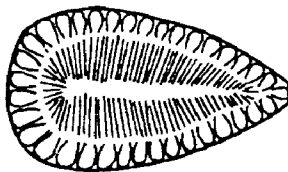
valve view



girdle view

Notes:

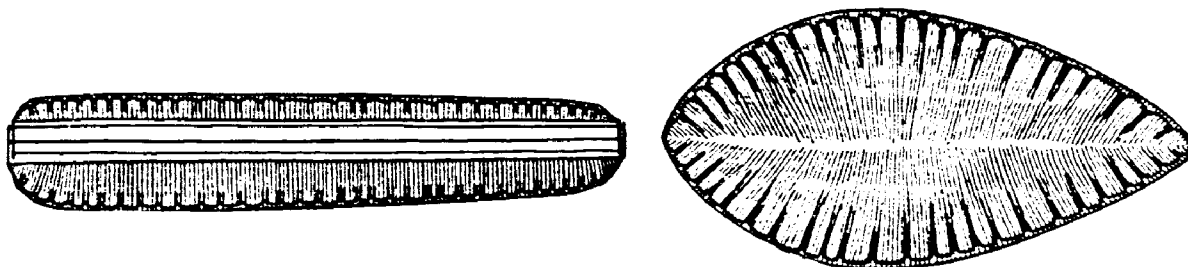
- Fig. 138. Surirella brightwellii, (7), cells 30-50 μ long, 15-30 μ wide; longitudinal folds not extended to the center; border raised. X 1000. In Arkansas and Colorado Rivers.



valve view

Notes:

Fig. 139. Surirella ovalis, (5), cells 20-100 μ long, 10-40 μ wide; 1.5-5 longitudinal folds in 10 μ ; striae distinct, about 16 in 10 μ . X 1000.

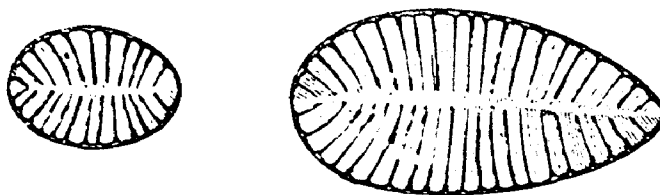


valve view

girdle view

Notes:

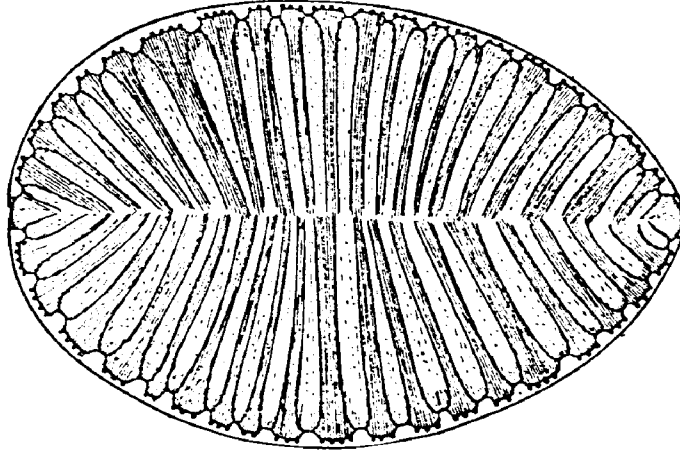
Fig. 140. Surirella ovata, (5), cells 10-70 μ long, 8-23 μ wide; longitudinal folds extend to the center, 4-7 in 10 μ ; striae fine but distinct, 16-20 in 10 μ . X 1000. Common in the southwest.



valve views

Notes:

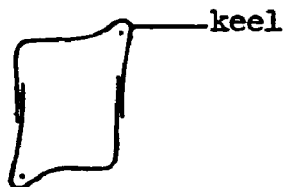
Fig. 141. Surirella striatula, (5), cells 80-260 μ long, 50-160 μ wide; longitudinal folds very wide, 0.6-1.2 in 10 μ ; small distinct protruberances on the outer edge of the longitudinal folds. X 400.



valve view

Notes:

- 42a Keels eccentric to the median axis, diagonally opposite; frustules rhombic in cross section, transversely striate, punctate or lacking ornamentation; a row of circular pores ("carinal dots") developed within the keel; frustules usually solitary but occasionally forming irregular ribbon-like chains or stellate colonies - NITZSCHIA



Diagrammatic cross-section of Nitzschia, (7).

Fig. 142. Nitzschia acicularis, (5), cells 40-150 μ long, 3-4 μ wide; carinal dots small, 17-20 in 10 μ ; frustule delicate. X 1000.



valve view

Notes:

Fig. 143. Nitzschia amphibia, (5), cells 12-50 μ long, 3-5 μ wide; 7-9 carinal dots in 10 μ ; striae with distinct punctae, 15-19 in 10 μ . X 1000.



valve views

carinal dot

Notes:

Fig. 144. Nitzschia angustata, (5), cells 20-110 μ long, 5-10 μ wide; carinal dots indistinct; 12-18 striae in 10 μ . X 1000.



valve view

Notes:

- Fig. 145. Nitzschia apiculata, (5), cells 20-50 μ long, 5-8 μ wide; differs from N. hungarica by having indistinct carinal dots; about 17-20 striae in 10 μ . X 1000. Common in the Arkansas River.



valve view

Notes:

- Fig. 146. Nitzschia denticula, (5), cells 10-100 μ long, 3-8 μ wide; carinal dots rib-like and extended, 5-8 in 10 μ ; 14-20 striae in 10 μ . X 1000. In southwest.



valve view

Notes:

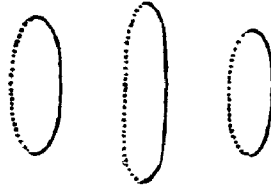
- Fig. 147. Nitzschia dissipata, (5), cells 15-70 μ long, 4-7 μ wide; keel slightly eccentric, 6-8 carinal dots in 10 μ ; striae indistinct. X 1000.



valve view

Notes:

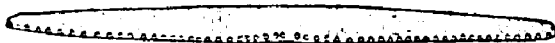
Fig. 148. Nitzschia elliptica, (6), cells 13-22 μ long, 5-6 μ wide; carinal dots small, 16-20 in 10 μ ; striae indistinct; frustule delicate. X 1000. At times abundant in the Arkansas River.



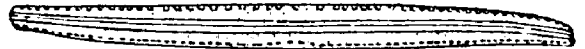
valve view

Notes:

Fig. 149. Nitzschia filiformis, (5), cells 20-100 μ long, 4-6 μ wide; 8-11 carinal dots in 10 μ ; about 36 striae in 10 μ . X 1000.



valve view



girdle view

Notes:

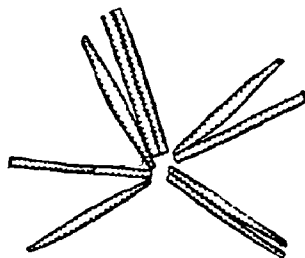
Fig. 150. Nitzschia fonticola, (5), cells 11-30 μ long, 2-4 μ wide; 12-15 carinal dots in 10 μ ; striae fine, but distinct, 28-30 in 10 μ . X 1000. In the Snake River.



valve view

Notes:

- Fig. 151. Nitzschia holsatica, (5), cells 20-55 μ long, 1.5-2 μ wide; 14-17 carinal dots in 10 μ ; striae fine; indistinguishable from other forms unless in the stellate colony. X 1000. Common in the southwest.



Colony

Notes:

- Fig. 152. Nitzschia hungarica, (5), cells 20-110 μ long, 6-9 μ wide; carinal dots distinct, 7-9 in 10 μ ; 16-20 striae in 10 μ . X 1000. Abundant in the southwest.



valve view

Notes:

- Fig. 153. Nitzschia lacunarum, (5), cells 65-75 μ long, 6-8 μ wide; carinal dots small, 7-8 in 10 μ ; about 30 striae in 10 μ . X 1000.



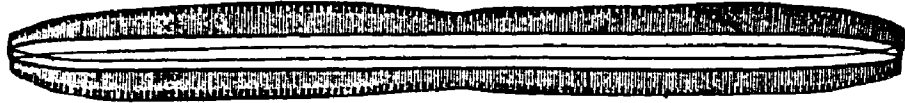
valve view

Notes

- Fig. 154. Nitzschia linearis, (5), cells 70-180 μ long, 5-6 μ wide; 8-13 carinal dots in 10 μ ; striae fine, 28-30 in 10 μ . X 1000. Common.



valve view



girdle view

Notes:

- Fig. 155. Nitzschia Lorenziana, (5), cells 65-160 μ long, 3-5 μ wide; 6-8 carinal dots in 10 μ ; striae distinct, 17-19 in 10 μ . X 1000.



valve view

Notes:

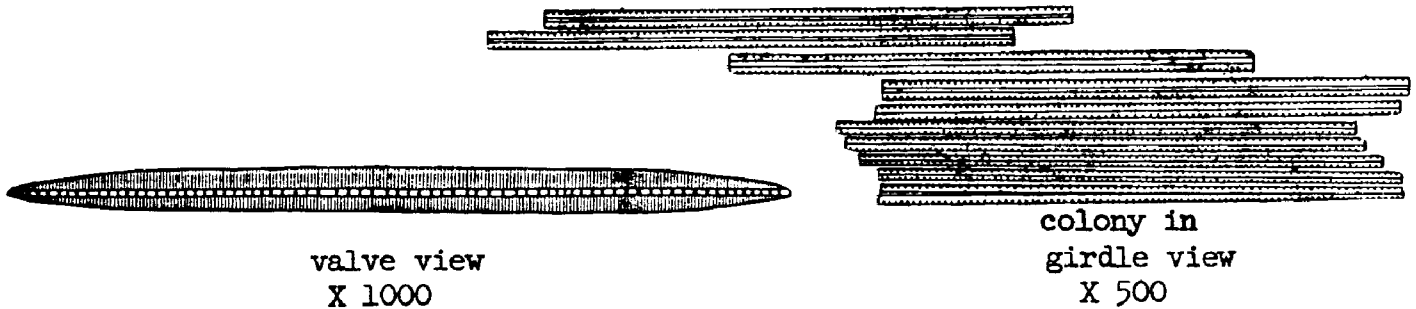
- Fig. 156. Nitzschia palea, (12), 20-65 μ long, 2-5 μ wide; 10-15 carinal dots in 10 μ ; striae very fine, 35-40 in 10 μ . X 1000. Widespread.



valve view

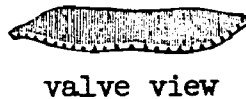
Notes:

Fig. 157. Nitzschia paradoxa, (5), cells 60-100 μ long, 4-6 μ wide; 6-8 carinal dots in 10 μ ; 20-25 striae in 10 μ ; do not confuse with N. dissipata.



Notes:

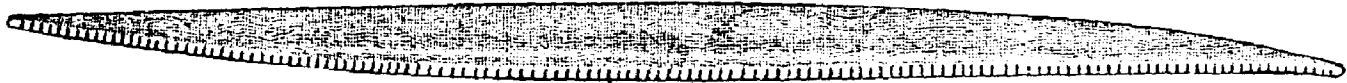
Fig. 158. Nitzschia parvula, (5), cells 20-40 μ long, 3-6 μ wide; 5-8 carinal dots in 10 μ ; striae fine, 30-35 in 10 μ . X 1000.



valve view

Notes:

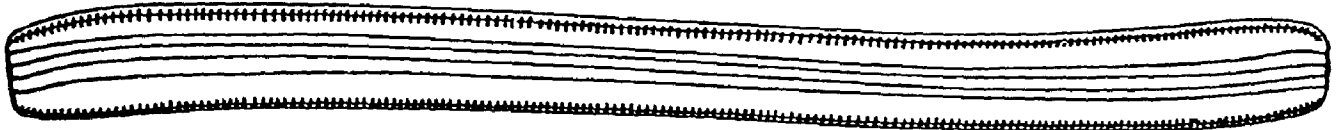
Fig. 159. Nitzschia sigma, (5), cells 50-70 μ long, 4-15 μ wide;
7-12 carinal dots in 10 μ ; 22-30 striae in 10 μ . X 1000.



valve view

Notes:

Fig. 160. Nitzschia sigmoidea, (3), cells 160-500 μ long, 8-14 μ
wide; 5-7 carinal dots in 10 μ ; striae distinct, 23-26
in 10 μ .



girdle view
X 500



valve view
X 1000

Notes:

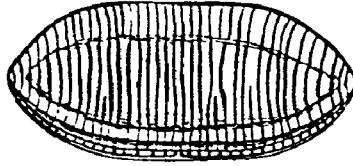
Fig. 161. Nitzschia sinuata, (5), cells 20-50 μ long, 5-8 μ wide;
5-6 carinal dots in 10 μ ; about 18 striae in 10 μ . X 1000.



valve views

Notes:

Fig. 162. Nitzschia tryblionella, (5), cells 30-100 μ long, 15-26 μ wide; about 6 carinal dots in 10 μ ; 5-7 ribs in 10 μ .
X 1000.

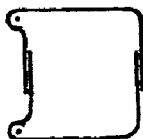


valve view
var. victoriae

Notes:

Notes on other species of NITZSCHIA

- 42b Keels eccentric to the median axis, directly opposite;
frustules rectangular in cross section, transversely striate
or punctate, capitate ends, medianly constructed - HANTZSCHIA



Diagrammatic cross-section of Hantzschia, (7)

- Fig. 163. Hantzschia amphioxys, (5), cells 20-100 μ long, 5-10 μ wide;
carinal dots not elongate, 5-8 in 10 μ ; 13-20 striae in
10 μ . X 1000. In the southwest.



valve view

Notes:

- Fig. 164. Hantzschia virgata, (5), cells 20-150 μ long, 6-12 μ wide;
carinal dots elongate, 4-6 in 10 μ ; 9-15 striae in 10 μ .
X 1000.

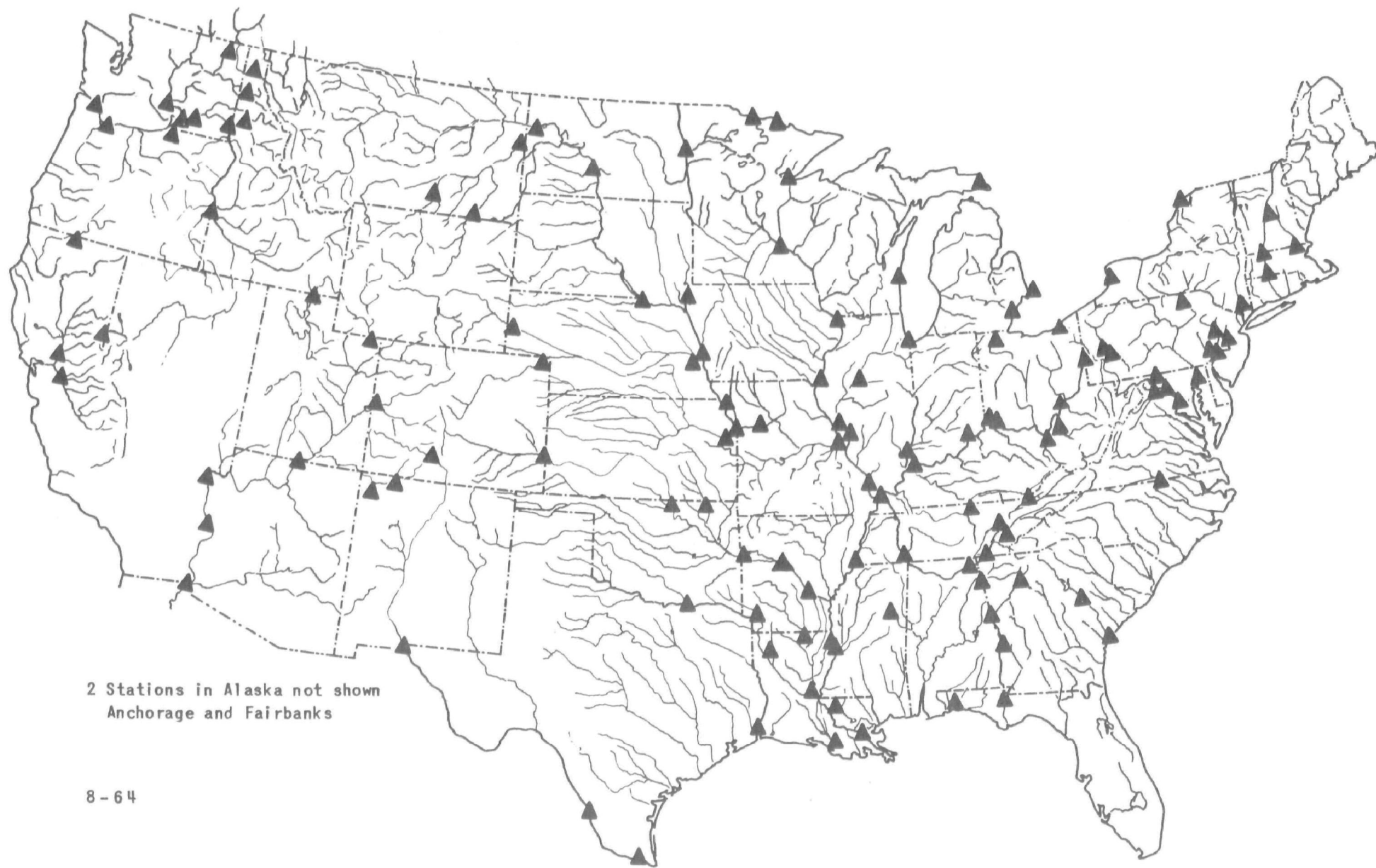


valve view

Notes:

PHS Water Pollution Surveillance System

SAMPLING STATIONS



2 Stations in Alaska not shown
Anchorage and Fairbanks

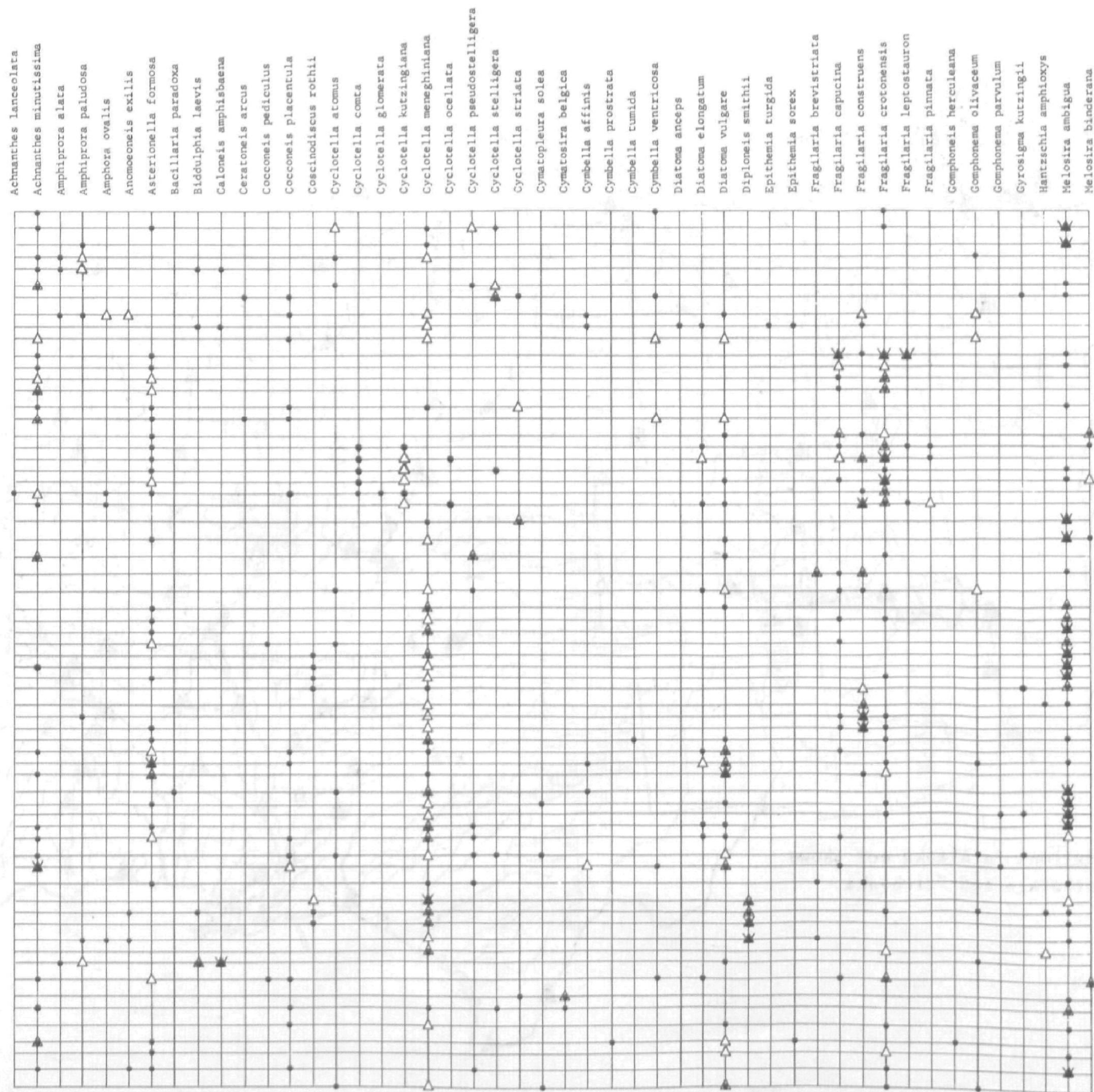
8-64

Occurrence of Four Most Abundant Diatom Species

OCURRENCE AS ONE OF THE FOUR
MOST ABUNDANT SPECIES OF DIATOMS

- - 1 to 25 PERCENT OF THE TIME
- △ - 26 to 50 PERCENT OF THE TIME
- ▲ - 51 to 75 PERCENT OF THE TIME
- ✱ - 76 to 100 PERCENT OF THE TIME

RIVER	STATION
ANIMAS	CEDAR HILL
APALACHICOLA	CHATTAHOOCHEE
ARKANSAS	PENDLETON FERRY PONCA CITY COOLIDGE
CHATTAHOOCHEE	COLUMBUS ATLANTA
COLORADO	YUMA PAGE LOMA
COLUMBIA	CLATSKANIE BONNEVILLE PASCO WENATCHEE
DELAWARE	PHILADELPHIA MARTINS CREEK
GREAT LAKES	BUFFALO MILWAUKEE DETROIT DULUTH GARY SAULT STE. MARIE PORT HURON
HUDSON	POUGHKEEPSIE
ILLINOIS	PEORIA
KANAWHA	WINFIELD
KLAMATH	KENO
LITTLE MIAMI	CINCINNATI
MISSISSIPPI (upper)	E. ST. LOUIS BURLINGTON DUBUQUE
(lower)	ST. PAUL NEW ORLEANS DELTA WEST MEMPHIS CAPE GIRARDEAU
MISSOURI	ST. LOUIS KANSAS CITY ST. JOSEPH OMAHA YANKTON BISMARCK WILLISTON
OHIO	CAIRO EVANSVILLE CINCINNATI HUNTINGTON EAST LIVERPOOL
POTOMAC	GREAT FALLS WILLIAMSPORT
RED (North)	GRAND FORKS
RED (South)	ALEXANDRIA INDEX DENISON
RIO GRANDE	BROWNSVILLE LAREDO EL PASO
ST. LAWRENCE	MASSENA
SAVANNAH	PORT WENTWORTH NORTH AUGUSTA
SCHUYLKILL	PHILADELPHIA
SNAKE	WAWAWAI WEISER
TENNESSEE	CHATTANOOGA
YELLOWSTONE	SIDNEY



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RIVER	STATION
ANIMAS	CEDAR HILL
APALACHICOLA	CHATTAHOOCHEE
ARKANSAS	PENDLETON FERRY PONCA CITY COOLIDGE
CHATTAHOOCHEE	COLUMBUS ATLANTA
COLORADO	YUMA PAGE LOMA
COLUMBIA	CLATSKANIE BONNEVILLE PASCO WENATCHEE
DELAWARE	PHILADELPHIA MARTINS CREEK
GREAT LAKES	BUFFALO MILWAUKEE DETROIT DULUTH CARY SAULT STE. MARIE PORT HURON
HUDSON	POUGHKEEPSIE
ILLINOIS	PEORIA
KANAWHA	WINFIELD
KLAMATH	KENO
LITTLE MIAMI	CINCINNATI
MISSISSIPPI (upper)	E. ST. LOUIS BURLINGTON DUBUQUE ST. PAUL
(lower)	NEW ORLEANS DELTA WEST MEMPHIS CAPE GIRARDEAU
MISSOURI	ST. LOUIS KANSAS CITY ST. JOSEPH OMAHA YANKTON BISMARCK WILLISTON
OHIO	CAIRO EVANSVILLE CINCINNATI HUNTINGTON EAST LIVERPOOL
POTOMAC	GREAT FALLS WILLIAMSPORT
RED (North)	GRAND FORKS
RED (South)	ALEXANDRIA INDEX DENISON
RIO GRANDE	BROWNSVILLE LAREDO EL PASO
ST. LAWRENCE	MASSENA
SAVANNAH	PORT WENTWORTH NORTH AUGUSTA
SCHUYLKILL	PHILADELPHIA
SNAKE	WAWAWAI WEISER
TENNESSEE	CHATTANOOGA
YELLOWSTONE	SIDNEY

